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The Largest of Ten-Wheeled Locomotives—Northern Pacific Railroad.

The Northern Pacific Railroad received last month from the Schenectady Locomotive Works two ten-wheeled compound freight engines which we believe can safely be pronounced the largest engines of that class ever built. The general design and details of the locomotives were worked out by Mr. E. M. Herr, Superintendent of Motive Power of the Northern Pacific Railroad, in consultation with the Schenectady Locomotive Works. Through the courtesy of these parties we publish herewith a full page engraving of one of the engines and the specifications.

The prominent characteristic of these engines may be expressed in two words: boiler power. Their great weight, 172,500 pounds, and several features of detail construction, are traceable to the effort to get an enormous boiler. That this has been attained is evident when we state that the heating rurface is nearly 2,900 square feet. All the details of the engines were designed with a view of giving the maximum of heating surface of boiler wit a given weight, to accomplish which, cast, forged and pressed steel were used extensively in place of cast and wrought iron.

The locomotives are of the two-cylinder compound type, having the Schenectady Locomotive Works design of intercepting valve which enables the engine to be operated either simple or compound at the will of the engineer. This intercepting valve is fully illustrated on page 127 in connection with the details of another large engine built for the same road. While operating compound on a 60-foot grade out of Schenectady, pushing freight trains, one of these 10-wheeled engines developed about 1,200 horse-power, and its operation in the test, both as compound and simple, was most satisfactory.

The boilers are of the radial stay extended wagon-top type, and in their general features are quite similar to the boilers for the Mastodon engines, illustrated on page 127. They are 70 inches in diameter at the front course and carry 200 pounds working steam pressure. The firebox is on top of the frames, the top rails of which are inclined back of the main drivers to give increased depth to the front end of the box.

The springs and equalizers are all underhung. The driving wheels centers are cast steel. The crank pins are hollow and the the parallel and main rods are all channelled and made as light as possible. The piston rod on the low-pressure side is extended through the front cylinder head. The rock shafts have hollow barrels.

The engine truck is of the swing motion type and the front and rear pair of drivers are flanged, the middle pair being plain.

The boiler front is of pressed steel, and pressed steel is we believe, used for several other parts of the engine. The cab is also of steel.

The specifications of the engine are as follows:

GENERAL DIMENSIONS.

Gage	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	172,500 pounds
" on drivers	120,000 pounds
Wheel base, driving	14 feet 10 inches
" " rigid	14 feet 10 inches
" " total	25 feet 11 inches

CYLINDERS.

Diameter of cylinders	High pressure, 22 inches; low pressure, 34 inches
Stroke of piston	26 inches
Horizontal thickness of piston	4¾ inches and 5¾ inches
Diameter of piston rod	3¾ inches
Kind " " packing	Cast iron rings, sprung in
" " " rod packing	Jerome metallic
Size of steam ports	High pressure, 20 inches by 2½ inches; low pressure, 23 inches by 2½ inches
" exhaust ports	High pressure, 20 inches by 3 inches; low pressure, 23 inches by 3 inches
" bridges "	1⅜ inches

VALVES.

Kind of slide valves	Allen-American
Greatest travel of slide valves	6½ inches
Outside lap " "	High pressure, 1¼ in.; low pressure, 1¾ in.
Inside clearance of slide valves	High pressure, ¼ in.; low pressure, ¼ in.
Lead of valves in full gear	0 inches
Kind of valve stem packing	Jerome metallic

WHEELS, ETC.

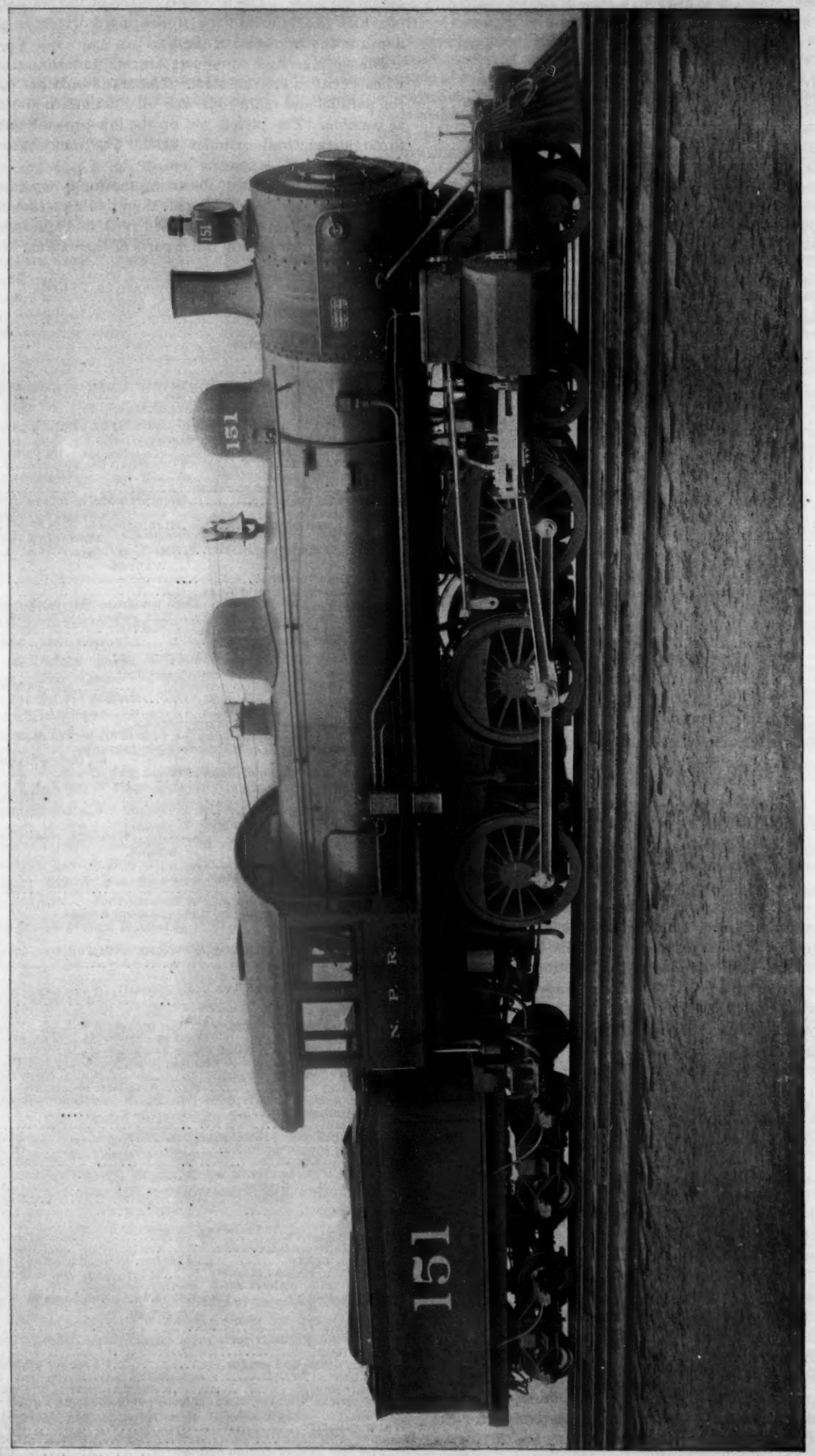
Diameter of driving wheels outside of tire	63 inches
Material of driving wheel centers	American cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diameter and length of driving journals,	Main 9 inches, F. & B. 8½ inches diameter by 11 inches
Diameter and length of main crank pin journals,	6½ inches diameter by 6 inches
Diameter and length of side rod crank pin journals,	Main 7 by 5¼ inches F. & B. 5½ by 4½ inches
Engine truck, kind	4 wheel swing bolster
Engine truck journals	6 inches diameter by 11 inches
Diameter of engine truck wheels	30 inches
Kind " " " "	Standard. steel tired spoke center

BOILER.

Style	Extended wagon top
Outside diameter of first ring	70 inches
Working pressure	200 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox,	11/32 inch, ¾ inch, 25/32 inch, 13/16 inch and ½ inch
Horizontal seams,	Butt joint, sextuple riveted, with welt strip inside and outside
Circumferential seams	Double riveted
Firebox, length	120⅛ inches
" width	41 inches
" depth	Front 84 inches, back 71½ inches
" " material	Car bon steel
" " plates, thickness, sides, 5/16 inches, back, 5/16	inches, crown, 3/8 inches, tube sheet, ½ inch
" " water space, front, 4½ inches, sides, 3½ inches	to 4 inches, back, 3½ inches to 4½ inches at crown
" " crown staying	Radial stays 1½-inch diameter
" " stay bolts	Ulster special iron 1 inch diameter
Tubes, material	Charcoal iron No. 12 W. G.
" number of	378
" diam	2 inches
" length over tube sheets	13 feet 6 inches
Fire brick, supported on	Four water tubes
Heating surface, tubes	2,655.4 square feet
" " water tubes	32.1 square feet
" " firebox	203.0 square feet
" " total	2895.5 square feet
Grate surface	34.22 square feet
" style	Rocking
Ash pan, style	Sectional
Exhaust pipes	Single, high
" nozzles	5¼ inches, 5½ inches and 5¾ inches diameter
Smoke stack, inside diameter	18 inches at top, 16 inches near bottom
" " top above rail	14 feet 10½ inches
Boiler supplied by	Two Sellers, improved Class M. No. 10½ injectors

TENDER.

Weight, empty	37,800 poundss
Wheels, number of	8, cast-iron plate wheels
" diam	33 inches
Journals, diam. and length	4½ inches diameter by 8 inches
Wheel base	15 feet 3 inches
Tender frame	10-inch steel channels
" trucks, 4-wheel, channel iron, center bearing F. & B. additional	side bearings on back truck
Water capacity	4,350 U. S. gallons
Coal "	9 (2,000 pounds) tons
Total wheel base of engine and tender	52 feet 9½ inches
" length " " " "	61 feet 4½ inches



COMPOUND TEN-WHEELED LOCOMOTIVE—NORTHERN PACIFIC RAILROAD.

E. M. HERR, *Superintendent of Motive Power.* *Built by the* SCHENECTADY LOCOMOTIVE WORKS.

The engine is provided with the American brake on all drivers, operated by air, the Le Chatelier water brake on cylinders, the Westinghouse automatic air-brake on tender and for train, Westinghouse air signal, three 3-inch Ashton safety valves, two of which are open pop and one with cam lever; the boiler is lagged with Sall Mountain asbestos, and the engine is also fitted with Dean's improved sand-feeding device, Kewanee reversible brake beams, McIntosh blow-off cocks and Star headlight with 16-inch round case.

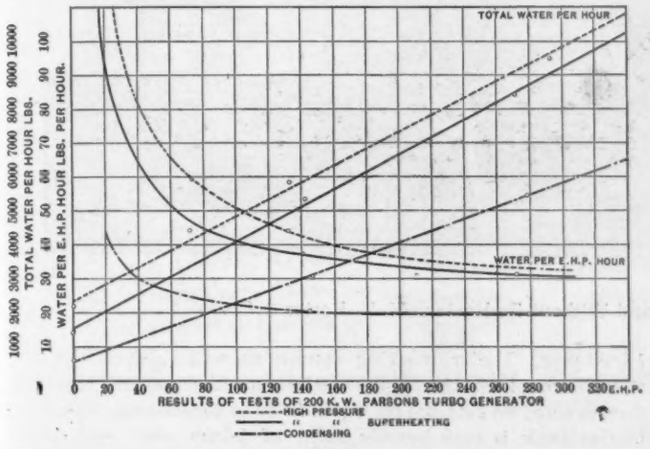
Test of a 200-Kilowatt Continuous-Current Parsons Turbo-Generator.

Last month we mentioned the remarkable performance of the "Turbina," a 100-foot boat fitted with Parson's steam turbines for furnishing the propelling power. Mr. W. D. Hunter has made public the following report of the test of one of Parson's turbo-generators, which is of interest in this connection:

On the 11th, 22d and 28th of January a series of tests were carried out on a 200-kilowatt continuous-current Parsons generator, for the purpose of determining the steam consumption under different conditions of service and various grades of output.

The generator was designed to work with a fair all-round economy, whether exhausting into the atmosphere or a condenser, although, in general, the latter method is expected to be employed.

The difficulty of obtaining high economy imposed by such a set of conditions can only be partially met in ordinary practice by adding to the engine a costly automatic expansion gear, which cannot always be relied upon when required to act within a widely fluctuating range of load, or when called upon suddenly to work at full power, either high pressure or condensing. In the case of the Parsons turbo-generator, the provision for expansion is constant, and when designed to exhaust into a condenser only the terminal pressure would be about 1½ pounds to the square inch, with an initial boiler pressure of 140 pounds, the steam being thereby expanded about 100 times. The degree of economy obtained under these conditions is already well known, the last 150-kilowatt generator supplied to the Newcastle and District Electric Lighting Company requiring only 17.28 pounds of water per electrical horse-power per hour at full load.


TOTAL WATER PER HOUR
WATER PER E.H.P. HOUR
TOTAL WATER PER HOUR LBS.
WATER PER E.H.P. HOUR LBS. PER HOUR.
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
10 20 30 40 50 60 70 80 90 100
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 E.H.P.
RESULTS OF TESTS OF 200 K. W. PARSONS TURBO GENERATOR
HIGH PRESSURE
" SUPERHEATING
CONDENSING

When, however, the motor is required to give full power, working either high pressure or condensing (with a moderate consumption of steam), the problem of how to meet conflicting requirements presents many difficulties, and the fact that these difficulties have been successfully met in the design of the generator tested, without any addition being made to the cost or parts of the machine, is further testimony to the adaptability of the steam turbine for every condition of service. The particular machine tested had one of the parallel flow type of turbines coupled direct to a continuous-current dynamo, designed for a normal output of 200 kilowatts. Steam was admitted at one end of the cylinder, the admission being controlled by an exceedingly sensitive and effective electrical governor which reduced or prolonged the period of admission without in any way altering the initial pressure at the steam chest of the motor; there was, therefore, a complete absence of throttling, with the attendant disadvantages which would be felt when working on a fluctuating load. The action of the governor left nothing to be desired, the rise in voltage being only momentary when the whole load of nearly 280 electrical horse-power was thrown off. Between full load and no load the generator responded to whatever calls were made upon it without any hunting, this valuable property eminently fitting it for electric traction or haulage purposes.

During the trials measurements of electrical output, steam pressure, vacuum, etc., were taken each time the water from measuring tanks were used up, the intervals at full loads being about eight minutes. The measuring tanks from which the feed water was drawn were carefully calibrated, and the electrical output was taken by a Kelvin watt-meter, the readings of which were checked by ammeters and voltmeters. The figures obtained during the trials are shown in the table herewith.

TESTS OF 200-UNIT TURBO-DYNAMO.

Kilowatts.	Total water per hour.	Water per kilowatt.	Water per electrical horse power.	
	Lbs.	Lbs. per hour.	Lbs. per hour.	
219.2	9,466	43.20	32.22	Non-condensing.
98.7	5,848	59.23	44.18	"
54.5	4,330	79.50	59.30	"
0	2,092			
203.0	8,429	41.52	30.97	Non-condensing and superheating 30 deg. Fahr.
106.0	5,287	49.83	37.17	
0	1,402			
208.0	5,443	26.16	19.51	Condensing but no superheating. Vacuum at full load 25 in.
108.4	3,037	28.02	20 90	
0	531			

It will be noted that for the full-power trials the water used per electrical horse-power hour, when exhausting into the atmosphere, 32.22 pounds. Under similar conditions, but with the steam superheated 30 degrees Fahrenheit, the consumption was 30.97 pounds. With saturated steam and exhausting into a condenser (vacuum 25 inches) the consumption fell to 19.51 pounds per electrical horse-power hour.

The generator ran throughout the trials smoothly and without a hitch, the automatic lubricating arrangements acting perfectly.

Rail Specifications.*

At the Atlanta meeting of the institute, October, 1895, I had the honor of presenting a paper on "Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghanies." In it, reasoning from the experience of Western railroads with heavier sectioned steel rails, I called attention to the importance of the chemical composition of the steel, and urged the increase of the carbon percentage and the limiting of phosphorus to the lowest point reconcilable with commercial considerations, and also insisted on the value of added silicon.† My paper has been honored by the favorable consideration of a number of the engineers and other controlling officers of Western roads, and it resulted in over 186,000 gross tons of rails of sections heavier than 65 pounds per yard being manufactured since that time in accordance with my views. These rails are in the tracks of several large railway systems. In giving the above tonnage I refer only to the rails which came under my immediate supervision—that is, under the inspection of my firm. Over 69,000 tons were 80 pounds to the yard.

In some cases it was not commercially possible to obtain quite as low a percentage of phosphorus as desired, and hence the carbon was reduced proportionately, but as a whole the rails could be classed as high carbon ones. Of course it is too soon to form a positive opinion in relation to the wear of the rails, but practically all of them have been in service long enough to demonstrate their safety, and I believe in all cases the users of the rails unite in the opinion that so far they promise much better wearing results than previously obtained; and I know in several instances, based on such showing, still harder steel will be insisted upon in this year's deliveries.

I present this short article somewhat in the nature of a "report of progress." Moreover, in view of the recent somewhat surprising developments in the American rail trade, it is well not to lose sight of the necessity of not permitting low prices to be the only consideration. The first cost of rails is not all the story. This does not require discussion. If it is necessary to pay a little more for a good rail, true economy speaks in no uncertain voice in favor of so doing. Low prices are very attractive, but subsequent

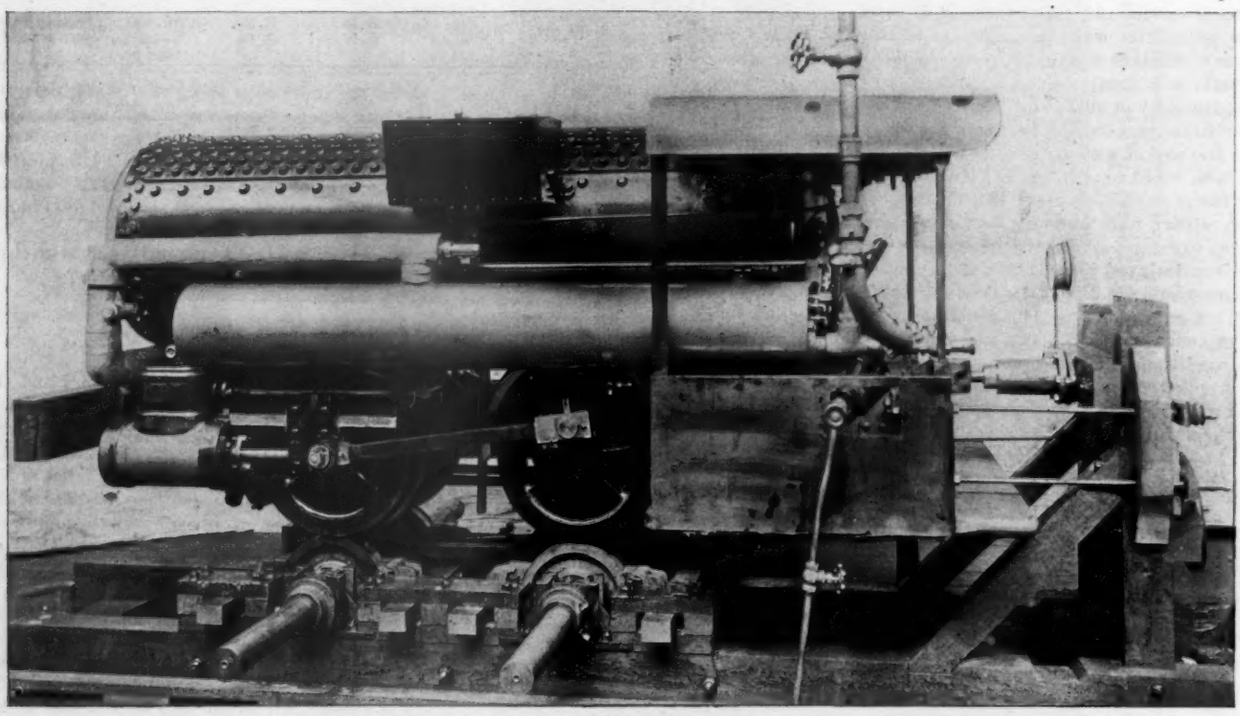
* By Robt. W. Hunt, at the meeting of the American Institute of Mining Engineers.

† The chemical composition advocated was: Carbon, in 70-pound rails 0.43 to 0.51; in 75-pound rails, 0.45 to 0.53; in 80-pound rails, 0.48 to 0.56; 90-pound rails, 0.55 to 0.63; 100-pound rails, 0.62 to 0.70; phosphorus not to exceed 0.085; silicon not below 0.10.

economies in track maintenance, repairs to rolling stock, possibilities of high speed and comfort of passengers must not be ignored. The peculiarities of human nature must be remembered. They do not change very much. When articles are sold at a low price those in direct charge of the manufacture of them will, most likely, be expected to keey cost of production down to a corresponding degree. This may lead to temptation to cut some corners which had better have remained in full projection. At all events, it does not seem wise to ignore past experience in steel-rail metallurgy.

Tests of a Compressed Air Locomotive With and Without a Re-Heater.

The firm of H. K. Porter & Company, of Pittsburgh, Pa., has recently built a compressed air locomotive for the Anaconda Copper Mining Company, of Anaconda, Mont., on which some interesting tests were conducted before it left the shops of the builder. The engine has 5 inch by 10-inch cylinders and is for an 18-inch gage of track. It is shown in the accompanying illustration mounted on friction rollers for the test, at which time indicator cards were taken, and dynamometer and revolution counter records obtained.



Tests of a Compressed Air Locomotive With and Without Re-Heater.—H. K. Porter & Co.

At the time the tests were made the company had nearby a compressed air street car charged with air at 2,000 pounds' pressure, and connected to the little locomotive by ¼-inch piping, so that the locomotive could be charged conveniently for the tests. There was also connected a large six-driver compressed air mine locomotive charged to 600 pounds. The friction rollers under the engine were arranged with brakes, to that by putting on the brake the resistance could be kept quite uniform, equivalant to the resistance of whatever the train might be in actual practice. For convenience the engine was run backward, the drawbar pushing instead of pulling. The dynamometer was a cylinder partly filled with oil, and proportioned so that 10 pounds' push on the piston registered one pound on the gage. Indicator cards were taken every minute, and during the hot test the temperature of the auxiliary reservoir was taken every minute. The revolutions and pressures were also taken every minute.

The dimensions of the locomotive are as follows; Cylinders, 5 inches by 10 inches; four driving wheels, 23 inches diameter; gage of track, 18 inches; height of locomotive, 4 feet 10 inches; width of locomotive, 4 feet 10 inches; length of locomotive, 10 feet 4 inches; pressure in main tank, 550 pounds; reduced pressure for auxiliary reservoir, 125 pounds; weight of locomotive, 10,000 pounds. The engine was built for the following work: Length of haul each way, 1,200 feet; load, 6 cars; weight of each car, 950 pounds; weight of load carried on each car, 2,500 pounds; track practically level; cars empty in one direction and loaded in the other. The engine was constructed to make two round trips, or 4,800 feet, with cold air, or three or four round trips with hot air.

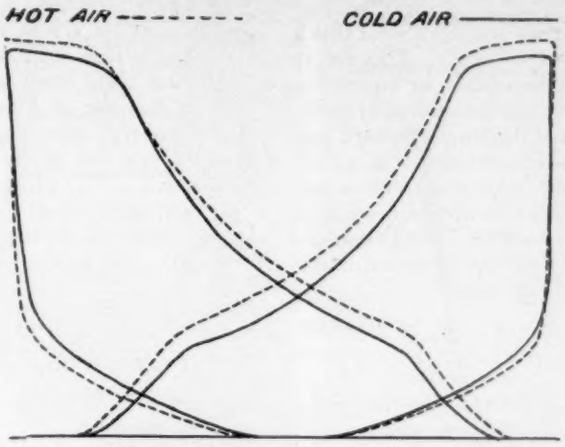
The tests proved that with hot air the engine was able to make over five round trips under working conditions, with plenty of reserve air to allow for switching, etc.; or, if there had been grades as steep as two per cent. against the loaded cars, the engine was found to have capacity to make four round trips with one charge of air. During the test it was found to take 60 seconds to raise the pressure from 150 pounds to 550 pounds through ¼-inch pipe. Under working conditions, with 1¼-inch pipe and metallic couplings, the engine can be stopped, connected, charged, disconnected and started off again in 30 to 45 seconds. The locomotive tank is very heavily built, of ½-inch steel and ¾-inch heads, with a manhole in the front end made of steel castings. All the longitudinal seams are heavy butt joints, treble riveted, and the circumferential seams double riveted. The tank was tested for strength to about 50 per cent. above the working pressure. The pop valve for the main tank was set to blow off at 550 pounds, and the pop valve for the auxiliary tank to blow off at 300 pounds.

For the hot test steam was furnished from the shop steam pipes at low pressure. In practice steam at about 90 pounds' pressure would be used, and on this basis there would be a gain of 50 per cent. or more in the use of the re-heater over working the air cold.

It was found in taking the indicator cards that the indicator could be operated continuously for quite a while, allowing retracing the diagram exactly over the same lines, showing extremely even and perfect distribution of air and accuracy of the reducing valve, and proper working of the locomotive. The

pressure in the auxiliary reservoir was found to be maintained constant, with almost no fluctuations.

The indicator cards show a little too early exhaust, but before the locomotive was shipped the valve motion was modified to make the exhaust open later in the stroke, for the sake of greater economy in the use of air. All the cards show absolutely no back



Comparison of Diagrams Using Hot and Cold Air.

pressure, even when working the engine with maximum loads This amounts to a constant advantage over steam practice of say 10 pounds or 15 pounds.

The results of the tests are given in the accompanying table, and appear to show quite clearly the great economy in the use of air with the re-heater.

RESULTS OF TESTS OF COMPRESSED-AIR LOCOMOTIVE WITH AND WITHOUT RE-HEATER.

	Without Re-heater.	With Re-heater.
Temperature atmosphere	57 deg.	60 deg.
Barometer	29.39	29.38
Time of run	15 min. 20 sec.	24 min.
Distance run (feet)	5,761.14	10,312.26
Number revolutions	957	1,713
Revolutions per minute	62.55	71.37
Tank-initial pressure (gage)	525 in.	550 in.
" final " "	70 "	45 "
" drop in " "	455 "	505 "
Aux. res. initial pressure (gage)	130 "	140 "
" " final " "	45 "	30 "
" " drop in " "	85 "	110 "
M. E. P. by cards (mean of test)	H. E. 50.68 lbs. C. E. 47.63 lbs.	H. E. 42.86 lbs. C. E. 41.06 lbs.
Mean dyn. push (corrected)	534.3 in.	467.2 in.
Aux. res. initial temperatur, Fahr		320 deg.
" " final " "		192 "
" " drop in " "		128 "
B. T. U. from water		17,811.2
B. T. U. delivered per pound. of air		148.91
Air delivered (in lbs.)	109.3563	119.6089
Work done at drawbar per cubic foot free air	2,140 ft. lbs.	3,100 ft. lbs.
Total work at drawbar	3,078,177.1 ft. lbs.	4,817,887.9 ft. lbs.
Work done at drawbar per pound of air delivered	28,148.4 ft. lbs.	40,283.2 ft. lbs.
Work including engine friction per cubic foot free air	2,450 ft. lbs.	3,600 ft. lbs.
Per cent. gain, hot air over cold air		47.1

We give herewith two indicator cards superimposed, one taken with the air cold and the other with it heated. The dotted card is for heated air. The data for these cards is as follows:

	Cold air.	Hot air.
Mean effective pressure, head end	46.66	52.45
" " " crank "	41.44	48.66
Cut off, head end	.30	.30
" crank "	.29	.29
Revolutions	58	72
Drawbar pull	479	437
Work done per minute (foot pounds)	167,248	189,413
Air used " " (pounds)	6,627	5,238
Work done per pound of air (foot pounds)	25,230	36,160
Per cent. gain over cold air		40

The company claims that actual results obtained in practice with other compressed air locomotives built by H. K. Porter & Company, demonstrate that power can be conveyed and used more economically by compressed air than by electricity. Actual figures show that, running the locomotive and the plant reasonably close to its full capacity. coal can be hauled at less than ¼ cents per ton per mile, including returning the empty trains, and also including a very large allowance for interest, depreciation and various contingencies. The cost of hauling coal, not reckoning interest, depreciation and contingencies, is less than ¼ cent per ton mile.

The Largest Locomotive Jib Crane.

What is stated to be the largest locomotive jib crane ever built has been erected at the United States Navy Yard, Mare Island, California, by the American Hoist and Derrick Company, of St. Paul, Minn. The crane has a capacity of 45 net tons raised at the rate of 14 feet per minute. The longest reach of the boom is 75 feet from the center of the track. and the reach of the boom, when the point is elevated, is 60 feet. The time required to raise the boom point from 75 feet to 60 feet is 11 minutes, and the time of slewing the boom a complete revolution is two minutes. The gauge of the track is 20 feet. The speed of travel of the crane along the track is 60 feet per minute.

The crane is operated by a 60-horse-power engine of the double cylinder type, with the cranks set at right angles. The boiler is of the vertical type, 4 feet in diameter by 10 feet in height. The crane deck rests upon 50 steel rollers. The large rotating rack is 23 feet in diameter. All the gearing is of cut cast steel and the large gear on the drum is 7 feet in diameter and weighs 3,200 pounds. The hoisting block weighs 1,500 pounds, the swivel working on hardened steel rollers. The wire rope is of plow steel $1\frac{5}{16}$ inch in diameter.

The platform of the crane is mounted upon four beams, arranged one at each corner, which are supported each upon a pair of two-wheeled trucks, the connections between trucks and beam and beam and platform being pivotal to permit freedom of adjustment of the truck-wheels to the curvatures of the track.

Between the front and rear trucks, on each side, is arranged a driving or traction wheel, the two being connected by a cross beam or truck, and each being double flanged to prevent derailment.—Iron Age.

Hardening Steel.

Metallurgists now think they know why a piece of red-hot tool steel becomes flint hard when suddenly quenched in water. For years they have been satisfied with the explanation that the shock drove the molecules of the steel into closer contact, hence the hardness, but this theory was completely destroyed by the fact that the volume of the hardened steel was greater than that of the unhardened material. After five years' search the metallurgical department of the Sheffield Technical School had solved substantially this difficult problem. It had been necessary to employ very intricate physical apparatus, the object of which was to measure accurately what seemed a paradox, namely, how much hotter a piece of steel became on cooling, and how much cooler it became on heating. These phenomena were due to the formation or dissociation of compounds within the steel itself. The result of the researches showed, almost beyond doubt, that the almost diamond hardness of quenched steel was due to the presence of a remarkable sub-carbide of iron, and that the action of tempering was due to the fact that far below red heat, this compound decomposed and diluted the mass with soft iron. The permanent magnetism of steel depended on the amount present of this compound.—Engineering Mechanics.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France.

BY M, L. TOLMAR,

GRADUATE OF L'ECOLE POLYTECHNIQUE,

CHIEF OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE,

AT MOHON (ARDENNES).

(*Continued from page 83.*)

COST OF MAINTAINING THE VARIOUS TYPES OF WAGONS.

Outside of the inspection of the cars and the small repairs that follow (tightening a bolt, replacing a screw, tightening a chain, etc.), we can divide the maintenance into two parts;

1st. The light or running repairs.

2d. The heavy repairs and alterations.

The work of light repairs requires only workmen of very ordi-

nary ability, but alert and well directed, and who understand only the assembling and taking apart of parts kept in stock. The car is usually out of service but one day. From this body of workmen the inspectors are selected, whose duties consist in inspecting the rolling stock, the repairs in case of damage, lubricating the journals, etc.

We have estimated the cost of repairs thus made to the underframes of nearly 15,000 cars in various shops in the Eastern Railroad of France and for each passage. The results are found in the following table, in which are included the general expenses of superintendence and the office, the indemnities for injury, sickness and absence on leave, heating and lighting, the shunting of cars with horses on repair tracks, the sinking fund for the buildings and rolling stock, and the interest on the capital tied up in the materials carried in the storehouse. Conforming to the general usage in France, Belgium and Germany, these general expenses are valuated at 100 per cent. of the cost of labor.

The time which elapses between two successive entrances of cars into the shops for heavy repairs may be fixed approximately as follows:

1st. Every 15 years for the cars with underframes of wood or of iron and wood mixed.

2d. Every 20 years for the cars with iron frames.

TOTAL REPAIRS OF THE CARS.

The cars wholly of wood that are about 30 years old are at the end of their career. They are, then, according to circumstances, either demolished or reconstructed, using the same ironwork. The reconstruction costs about 30 per cent. of the cost of a new car, and the same ironwork might possibly undergo this reconstruction twice, that is to say, the ironwork would last 50 to 60 years if repaired and kept in good condition, the cost of which is included in the expenditure of the 30 per cent. above mentioned. But it must be observed that so far as the frame itself is concerned, the cost of reconstruction is practically equal to the cost

AVERAGE COST IN FRANCS OF ONE LIGHT REPAIR TO CARS OF VARIOUS TYPES.

Kind of frames.	Class of Cars.											
	Flat cars.				Uncovered cars.				Covered cars.			
	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.	Material.	Labor.	General expenses (100 per cent.).	Average total expense per each small repair.
Wood	6.13	2.36	2.36	10.85	3.70	1.51	1.51	6.72	3.46	2 23	2.23	7.92
Mixed	2.30	1.54	1.54	5.38	2 65	1.05	1.05	4.75	3.34	1 64	1.64	6.62
Iron	0 95	0 70	0.70	2 35	0.80	0.62	0.62	2.04	1.31	0.73	0.73	2.77

On the other hand, a very complete statistical statement demonstrates that the intervals of time between repairs differ greatly with the various types of cars. The annual expenses for repairs are as follows:

ANNUAL COST IN FRANCS OF REPAIRS TO CARS.

Kind of frame.	Class of cars.					
	Flat cars.		Uncovered cars.		Covered cars.	
	Average time elapsing between two light repairs.	Annual cost per car.	Average time elapsing between two light repairs.	Annual cost per car.	Average time elapsing between two light repairs.	Annual cost per car.
Wood	6 mos.	21.42	3 mos.	26 04	5 mos.	17.04
Mixed	8 mos.	7.95	3 mos.	18.48	6 mos.	12.44
Iron	11 mos.	2.16	4 mos.	5.31	14 mos.	2.17

Although the average expense of the heavy repairs depends upon many circumstances—method of construction, kind of material, age of car, damages that it has undergone, etc.—the same work carried out for the heavy repairs has given the following results, which appear acceptable since they cover a large number of cars:

of a new frame less the ironwork valued at about 25 francs ($5), and the economy of reconstruction depends chiefly upon the utilization of the box, the draw-gear and buffers and the running gear.

To these expenses it is proper to add the depreciation the car undergoes in service, notwithstanding it has been well cared for. Practically and for the determination of indemnities in case a car is destroyed on a neighboring line, the French companies fix the annual depreciation by the formula $\frac{4\ P}{600}$ where P is the first cost of a new car, deduction being made for the wheels and axles.

GRAPHIC REPRESENTATION OF THE RESULTS OF THIS DISCUSSION.

In order to bring these data together and to make the results more clear we will use a graphic method consisting of rectangular co-ordinates, in which expenses will be represented by ordinates and the time since the date on which the car was constructed by obscissas. In this diagram the line A is for the wooden cars, B is for the cars with mixed frames and C is for the cars with iron frames, corresponding respectively to the prices of these different frames which have been approximately averaged at

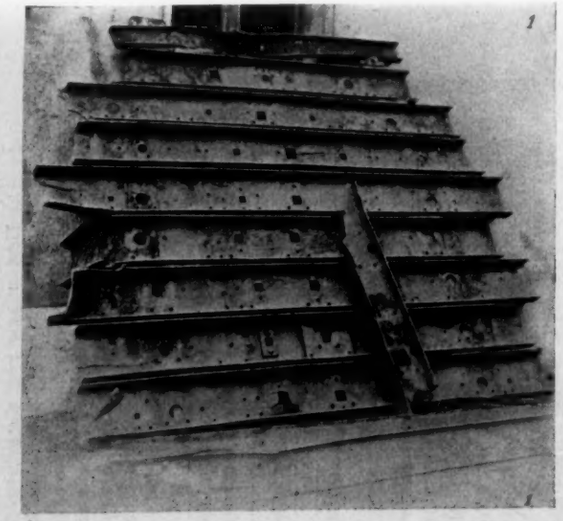
180 francs ($36) for wooden framed from 4 to 5 meters (13.1 to 16.3 feet) long.

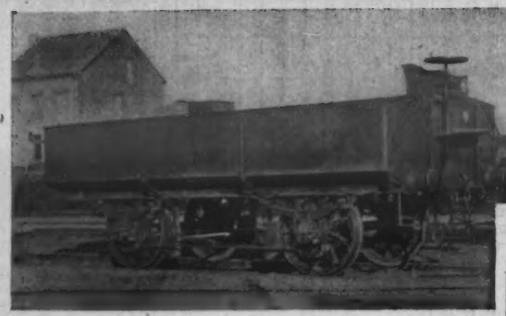
260 francs ($52) for mixed frames from 5 to 6 meters (16.3 to 19.7 feet) long.

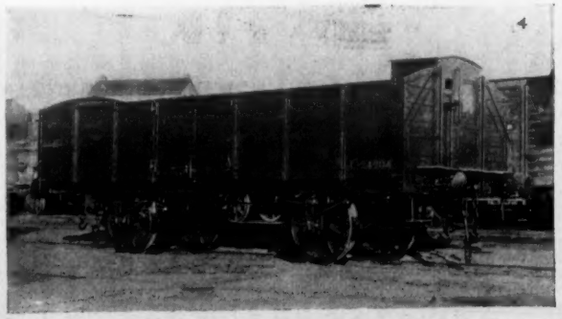
AVERAGE COST IN FRANCS OF ONE HEAVY REPAIR TO VARIOUS CLASSES OF CARS.

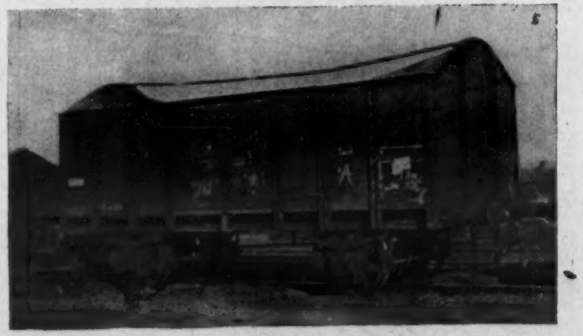
Kind of Frames.	Class of cars.											
	Flat Cars.				Uncovered Cars.				Covered Cars.			
	Material.	Labor.	General expenses.	Average total cost of one heavy repair.	Material.	Labor.	General expenses.	Average total cost of one heavy repair.	Material.	Labor.	General expenses.	Average total cost of one heavy repair.
Wood	91.50	35.75	35.75	163.00	64 77	29.23	29 23	123.23	14.98	11.29	11.29	37.56
Mixed	34.21	22.50	22.50	79.21	28.22	15.36	15 36	58.94	21.86	15.15	15.15	52.16*
Iron	7.76	10.54	10.54	28 84	8.21	10.10	10 10	28.41	9.46	7.80	7.80	25.06

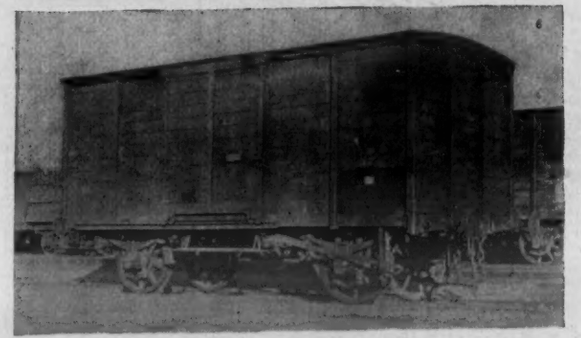
* These figures appear abnormal, which must be attributed to some special circumstances, and must be accepted with reserve.

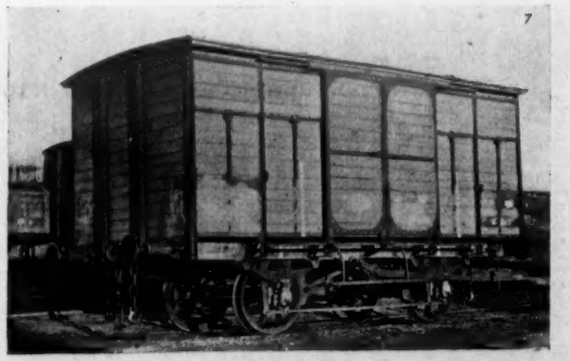


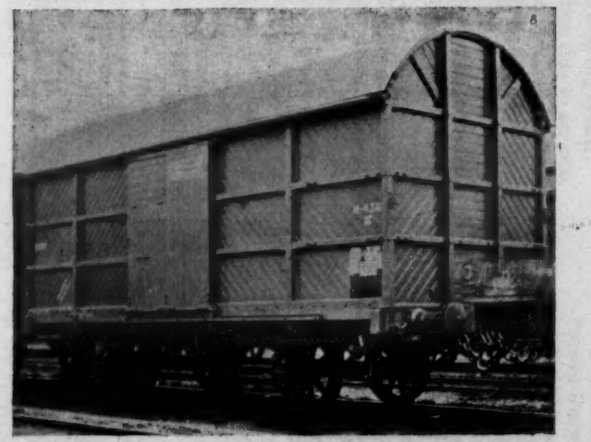


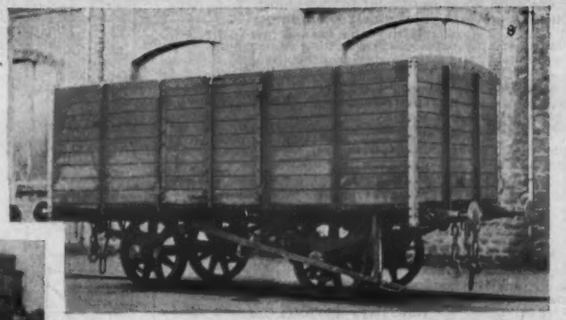












1.—View of iron sections deformed by collisions. 2.—10-ton flat car on Eastern Railroad, iron frames. 3.—10-ton car with iron body and frames, on annexed line of Eastern Railroad.

4.—15-ton car with iron frames and wooden box with doors on Eastern Railroad. 5.—10-ton car with iron frames and box and with doors, Belgian State Railway. 6.—10-ton covered cars with iron frames and wooden box, Eastern Railroad. 10.—30-ton flat car with iron frames and trucks, Eastern Railroad.

7.—7-ton covered car with iron upper and under frames, Paris, Lyons, Meditteranean Railroad. 8.—10-ton covered car with iron upper and under frames, Belgian State Railways. 9.—20-ton car with iron upper and under frames, Eastern Railroad.

VIEWS OF FRENCH AND BELGIAN CARS WITH IRON FRAMES.

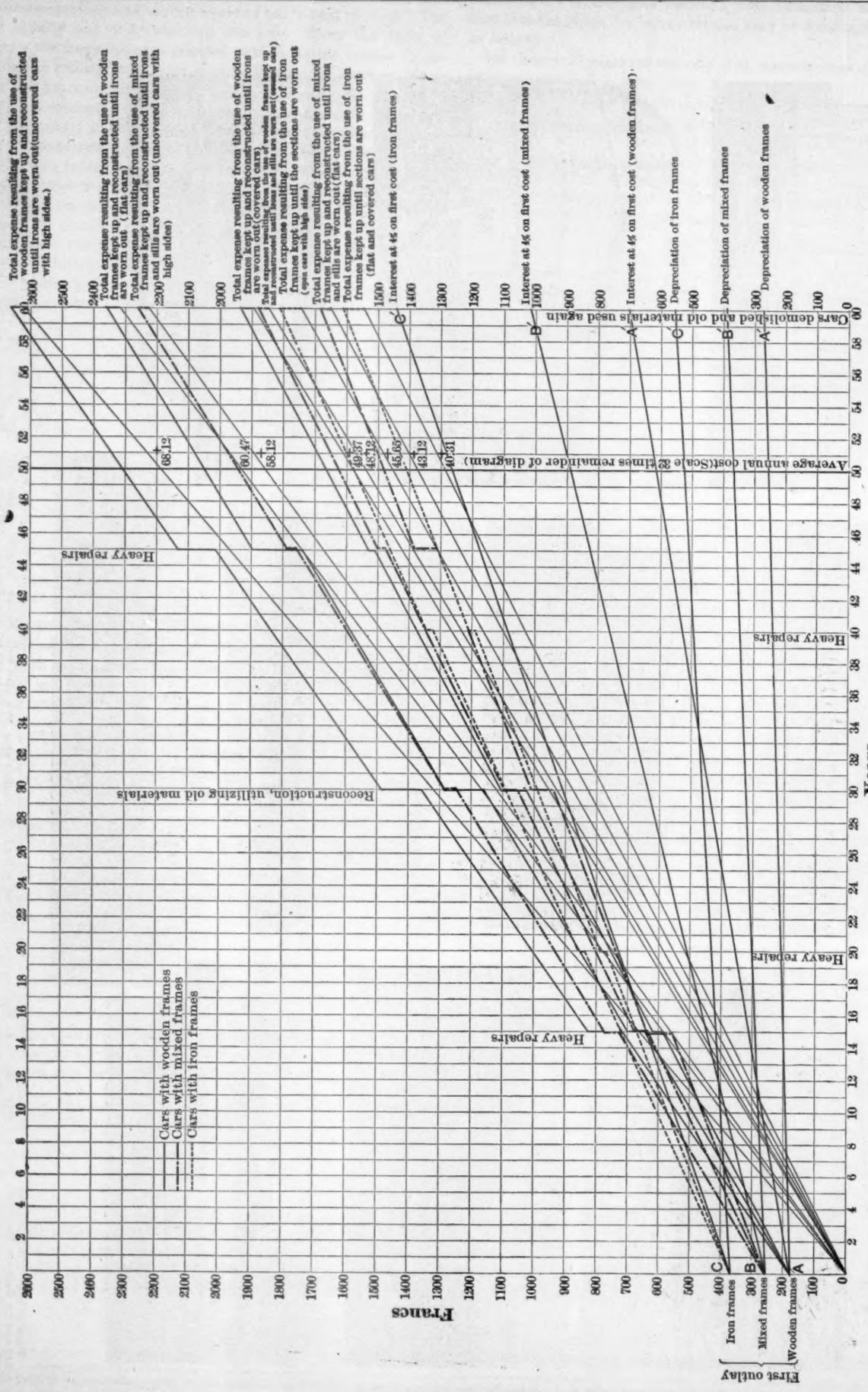

Francs
Years
Average annual cost(Scale 25 times remainder of diagram)
Cars with wooden frames
Cars with mixed frames
Cars with iron frames
Heavy repairs
Reconstruction, utilizing old materials
Interest at 4% on first cost (mixed frames)
Interest at 4% on first cost (wooden frames)
Depreciation of iron frames
Depreciation of mixed frames
Depreciation of wooden frames
Cars demolished and old materials used again
Total expense resulting from the use of wooden frames kept up and reconstructed until irons are worn out (uncovered cars with high sides.)
Total expense resulting from the use of wooden frames kept up and reconstructed until irons are worn out (flat cars)
Total expense resulting from the use of mixed frames kept up and reconstructed until irons and sills are worn out (uncovered cars with high sides)
Total expense resulting from the use of wooden frames kept up and reconstructed until irons and sills are worn out (flat cars)
Total expense resulting from the use of wooden frames kept up and reconstructed until irons and sills are worn out (covered cars)
Total expense resulting from the use of iron frames kept up until the sections are worn out (open cars with high sides)
Total expense resulting from the use of mixed frames kept up and reconstructed until irons and sills are worn out (flat cars)
Total expense resulting from the use of iron frames kept up until sections are worn out (flat and covered cars)
Interest at 4% on first cost (iron frames)
68.12
60.47
58.12
49.37
48.12
45.55
43.12
40.31
First outlay
Iron frames
Mixed frames
Wooden frames

DIAGRAM SHOWING COST OF MAINTENANCE OF FRENCH FREIGHT CARS WITH WOODEN, MIXED AND IRON UNDERFRAMES.

370 francs ($74) for iron frames from 7 to 8 meters (23 to 26.3 feet) long.

Into the computation we bring the following items:

1st. The amount of normal depreciation due to service.

2d. Interest at 4 per cent. on the cost of the frames.

This gives the lines $A A^1$, $B B^1$, $C C^1$, the ordinates of which are next increased by

1st. The cost of light repairs proportioned to the time.

2d. The heavy repairs made at the end of 15 years on the wooden and mixed frames.

3d. The cost of construction after 30 years of service, using the old ironwork, and diminished by the deduction at each reconstruction and at the final demolition of the value of the scrap and old material, estimated at one-sixth the price of a new frame. This gives us the full lines for the wooden frames, the broken lines for the mixed frames and the dotted lines for the iron frames.

We cannot attach to the graphic representation a significance not derived from the data on which it is based, but the facts are so strikingly illustrated that one cannot but accept the following deductions and conclusions:

CONCLUSIONS.

1st. In an enterprise or undertaking of a transitory nature one can be content with wooden cars, which for 15 years will not involve expenses greater than those of mixed or iron frames.

2d. An enterprise of long duration should seek permanence in its constructions, at the risk of diminishing a little the benefits accruing during the earlier years, and to this end must use metallic frames.

3d. Concerning cars generally but little used, our covered cars for example, the mixed frames can often be quite judiciously employed, uniting the advantages of both wooden and iron frames.

We admit that a serious objection can be made because of this last remark, namely, that we have after all occupied ourselves chiefly with the frames and not with the whole of the car. To that objection we will answer that that which is true of the frames of European cars, which are of small expense compared with the total price of the car, will certainly be true for a car with bogies or trucks in which the cost of the frame is a greater proportion of the total cost of the car.

All the data which serve as a basis for the preceding calculations are, on the other hand, capable of being modified under some circumstances so as to make the metal frames even more economical than appears in these calculations. On European roads the need of reducing the expense of maintenance is not always the dominant motive which guides the engineer in charge of the designs. Several other considerations, such as those resulting from obligations to the military service, to the customs, etc., enter into account. No doubt if freed from such considerations and by taking advantage of recent progress, we can obtain a most excellent solution of the problem.

As a closing word, we might say that the experience acquired in Europe with cars carried on bogies is limited to a few specimens. We give herewith a view of one of the cars constructed by the Eastern Railroad of France, which may be considered a good type and one which requires but small expense for maintenance.

Railway Engineering at Purdue University.

We have received from Purdue University a circular with the above title, which we believe to be so important to railway interests, and so much in line with what we believe is needed for the technical education of those who propose to enter the railway field, that we print it in full:

American railways are entering upon a period of development the conditions of which are more exacting than any they have hitherto experienced. With an enormous expansion of the volume of traffic, with a demand for increased speed and the consequent necessity for attention to the question of safety, and with an ever-increasing competition, there is need for the highest possible efficiency in every department of railway service, and, consequently, a demand for men who are thoroughly trained for the service they are expected to render. In the future many of these men will come from the technical schools, and for this reason it seems desirable that these schools arrange courses which shall have special reference to the requirements of such service.

Purdue University has for several years offered work covering a considerable variety of railway subjects; but recently, to provide more perfectly for the railway interests, the plan of existing work has been revised and extended until there are now offered, for the year beginning Sept. 15, 1897, eleven systematic courses and a series of special lectures. Courses, numbered one to four inclusive, are open to regular students in mechanical engineering; five to eight inclusive, to regular students in civil engineering, and seven to eleven inclusive, to all engineering students. All of these courses are open to graduate students. They are as follows:

1. *Railway Equipment.*—Recitations and lectures on locomotive construction, principles of locomotive design, a comparative study of locomotive details, car design, train brakes and signals, and car lighting, heating and ventilating.

2. *Locomotive Performance.*—An analytical study of the performance of simple and compound locomotives as shown by the results of road and shop tests, and a study of conditions affecting locomotive efficiency.

3. *Laboratory Work.*—(*a*) Locomotive testing involving practice in taking all observations incident to complete efficiency tests of locomotive Schenectady, and in working up observed data obtained from such tests; also tests of Purdue's Baldwin compound locomotive engine.

(*b*) Locomotive tests in series arranged for the purpose of showing the effect upon the efficiency of the machine, of changes in the proportion of parts and of changes in adjustment or of conditions.

(*c*) Tests to determine the performance of air pumps, of several elements of the Westinghouse brake system, and of systems of car lighting.

4. *Locomotive Design.*—Drawing-room practice in the design of locomotive details and in calculating their strength and deflection.

5. *Railway Surveying.*—Including reconnaissance, field location, levels, topography, construction of map, profile and grade lines.

6. *Railway Construction.*—Recitations and lectures in cross-sectioning, classification and computation of quantities, estimates, track-laying including yard construction, trestling, bridging, methods of pile-driving, pile foundation, supporting power of piles, railway culverts, bridge abutments and piers.

7. *Economics of Railway Location.*—Recitations and lectures on sources of income, operating expenses, effect of details of alignment, of gradients and curvature, and economy of construction.

8. *Laboratory Work.*—Tests to determine the strength and other physical properties of various elements common to railway construction, such as links, pins, turn-buckles, axles, channels, rails and rail joints; also tests of standard specimens of different constructive materials.

9. *Railway Chemistry.*—Lectures and laboratory practice concerning the general applications of chemistry to railway interests; the chemistry of iron and steel, fuels, water, lubricants and paints, and concerning chemical requirements in specifications.

10. *Railway Economics.*—Lectures on the industrial importance of the railway, general principles underlying railway management, the organization of railway departments, the business administration of railways, railway rates and the railway and public opinion.

11. *Railway Sanitation.*—A study of the sanitary conditions of railway cars and stations; preparation for emergencies, health of employees and educational and financial aspects of sanitation.

In addition to the preceding courses, which will be administered by members of the University Faculty, a series of lectures will be given by men high in their profession and representing different departments of railway organization, upon subjects relating to their departments. These will be open to all engineering students. The following is a partial list arranged alphabetically of those who will take part in this course during the school year of 1897 and 1898:

Jacob N. Barr, Superintendent Motive Power. C., M. & St. P. Railway Company, Milwaukee. (Subject to be announced.)

J. T. Brooks, Second Vice-President Penn. Lines west of Pittsburgh. "Problems in the Management of a Railway System."

Frederic A. Delano, Superintendent Freight Terminals, C., B. & Q. Railway Company, Chicago. "Signaling."

Frank G. Darlington, Superintendent P., C., C. & St. L. Railway Company, Indianapolis. "The Management of Men."

Charles B. Dudley, Chemist, Pennsylvania Railway Company, Altoona. "The Application of Chemistry to the Railroad."

Addison C. Harris, Attorney-at Law, Indianapolis. "Railway Law."

Melville E. Ingalls, President of the Big Four System, Cincinnati. "Railways; Their Past, Present and Future."

George K. Lowell, General Superiniendent L., N. A. & C. Railway Company, Chicago. "Practical Points in the Operation of a Railway."

John W. Noble, ex-Secretary of Interior, St. Louis, Mo. "The Mutual Obligations of Railroad Corporations and the People."

Robert Quayle, Superintendent Motive Power and Machinery, C. & N. W. Railway Company, Chicago. "Business Problems of the Motive Power Department."

Godfrey W. Rhodes, Superintendent Motive Power, C., B. & Q. Railway Company, Aurora, Ill. (Subject to be announced).

Angus Sinclair, Editor Locomotive Engineering, New York City. "Reminiscences of a Locomotive Engineer."

Arthur M. Waitt, General Master Car Builder, L. S. & M. S. Railway Company, Cleveland. "Car Designing and Construction."

A full description of the work required of students in civil and mechanical engineering will be found in the annual catalogue of the university.

For further information concerning this special railway work application may be make to Prof. W. F. M. Goss, or to

JAMES HENRY SMART,
President Purdue University,
LaFayette, Ind.

March 1, 1897.

High Carbon Steels for Forgings.*

BY A. L. COLBY, SOUTH BETHLEHEM, PA.

It is only in recent years that high carbon steel has been found available for this class of work. Friedrich Krupp, of Essen, was the leader in substituting his soft crucible steel for wrought iron in heavy forgings. After 1870 soft open-hearth steel became a more frequent substitute with such success that, compared with wrought iron, the soft steel forgings made by such firms as Vickers Sons & Company, of Sheffield, and Sir Joseph Whitworth & Company, of Manchester, England, soon attained a high reputation for their quality.

Shafting.—It was, therefore, natural that our government officials, when first issuing specifications for the heavy engine and shafting forgings required for the rebuilding of our navy, followed in the line of the English practice and called for a steel having a tensile strength in the specimen cut from the forgings of 28 to 30 tons (62,720 to 67,200 pounds) per square inch, and a minimum elongation of from 22 to 28 per cent., according to the dimensions of the specimen and the severity of the specifications. To-day, however, the Bethlehem Iron Company are called upon by the government to furnish a steel for thrust, line and propeller shafts which will show a tensile strength of 80,000 pounds (36 tons), an elastic limit of 50,000 pounds (22 tons), and an average elongation of 25 per cent. in four diameters, and the International Navigation Company also specify for shafting a steel of an elastic limit of 50,000 pounds and 25 per cent. elongation in four diameters. These requirements are met by using a steel of 30 carbon and 3¼ per cent. nickel.

Crank Pins.—The character of steel now used by some railroads for crank pins furnishes a marked illustration of the practicability of using high carbon steels. When steel was first used in such pins in place of wrought iron a soft low carbon steel was generally employed, and the failures due to "fatigue" of the metal were almost as numerous as when wrought iron was used. The broken pins showed what has been called "a fracture in detail," a gradual parting of the steel extending inward all around the piece, undoubtedly produced by the working strains repeatedly approaching the low elastic limit of the soft steel. On substituting a steel with an elastic limit of 45,000 pounds failures were greatly diminished, and that without changing the diameter or shape of the pin. We make crank pins of fluid compressed open-hearth steel of about the following composition, which have given excellent satisfaction in locomotive service:

Carbon	0.40-0.45
Manganese	0.60-0.70
Phosphorus and sulphur	0.030
Silicon	0.10-0.18

This same grade of steel is now being used by such firms as the Southwark Foundry & Machine Company, Philadelphia; the Corliss Steam Engine Company, Providence; the Atlantic Works, East Boston; Fraser & Chalmers, Chicago, for piston and connecting rods and crank pins, under specifications of 40,000 to 45,000 pounds elastic limit and 18 to 20 per cent. elongation.

Hammer Rods.—The use of soft steel for piston rods for steam hammers, especially for those of large sizes, is a good example of the error into which engineers have been led by the exercise of a caution which was not based on a thorougn knowledge of the facts. The argument that the soft steel was safer, because less liable to rupture if subjected by accident to a sudden transverse blow, has caused engineers to select so soft a steel that it was unable to resist for any length of time the strains put on it in regular service, strains which so constantly closely approach the low elastic limit of soft steel that the metal breaks down from gradual fatigue, causing distortion, which is soon followed by fracture, Some years ago we persuaded a customer to allow us to use a 45 carbon steel for a hammer rod. This rod was 19 feet long. the lower half 18 inches in diameter, and the upper half 10 inches. The machined weight was 6 tons. We used a fluid compressed ingot containing carbon, 0.45; manganese, 0.48; phosphorus, 0.025; sulphur, 0.030; silicon, 0.144. This rod stood very service for three years and seven months, which was so much longer a period than the soft steel hammer rods previously used had lasted that our customer, in ordering one to replace it, asked us to make the carbon still higher. We have, therefore, furnished a rod which is now in use, selecting a steel analyzing carbon, 0.55; manganese, 0.74; phosphorus, 0.024; sulphur, 0.030; silicon, 0.181, and obtained the following results on a 2-inch test bar, machined cold, from a prolongation of the forging after finished annealing: Tensile strength, 103,390; elastic limit, 53,980; elongation, 17.10; contraction, 28.76. A similar example of the success attending the substitution of a higher carbon steel is found in the record of a ram for a 20-ton hammer, where excellent service has been obtained from a 0.43 carbon steel. The test-piece from the finished annealed forging gave the following results: Tensile strength, 87,440; elastic limit, 48,060; elongation, 15.00; contraction, 63.84. In the cases just cited the forgings were simply annealed after forging. The following record shows the advantages gained by oil tempering high carbon forgings: We furnished a piston rod for a 20-ton hammer made of 0.45 carbon steel, which has now been in use five years nine months. The rod is 19 feet 4 inches long and 12 inches diameter, and has a 4-inch axial hole bored after forging. After forging and boring it was annealed, oil tempered and re-annealed, and a test bar taken from a prolongation of the forging after final treatment gave the following results: Tensile strength, 88,970; elastic limit, 50,100; elongation, 22.85 per cent.; contraction, 47.07. The analysis of this steel is: Carbon, 0.46; manganese, 0.63; phosphorus, 0.021; sulphur, 0.026; silicon, 0.155.

Selection of Steel for Forgings.—No fixed rules can be framed in the selection of steel for forgings, as the size and shape of the piece and the qualities most desirable for the work it is intended to do make each case almost a separate study. In general, however, it can be stated that our experience shows us that where high duty is demanded from a forging, mild steel of a tensile strength of 60,000 pounds (28 tons) is not the best material to use, owing to its low elastic limit. In substituting hard or higher carbon steel we recommend that the forging should be oil tempered whenever practicable, as this treatment effects a decided improvement in the physical qualities, increasing both elastic limit and toughness. The less the sectional thickness of the piece the more its qualities are improved by tempering. In order to successfully temper a large forging, especially if cylindrical in shape, it is necessary to provide it with an axial hole throughout its length. In cases where oil tempering is not prac-

* Read before the Engineers' Club of Philadelphia.

ticable and special requirements are demanded, they can be obtained by using a somewhat softer and tougher steel and the introduction of from 3 to 4 per cent. nickel. This nickel increases the ratio between the elastic limit and tensile strength, and also adds to the ductility of the steel. The following statement shows the average physical qualities that can be obtained in forgings made of the several grades of steel mentioned, the test specimens being ½ inch diameter and 2 inches long between marks and cut from full-sized prolongations of the forgings after treatment, the elastic limit being determined, not by the drop of the beam, but by an electric micrometer:

	Mild steel, annealed.	Medium hard steel, annealed.	Medium hard steel, oil tempered. (Axial hole where practicable.)	Medium hard nickel steel, annealed.	Medium hard nickel steel, oil tempered (Axial hole where practicable.)
Tensile strength	63,000	80,000	90,000	85,000	93,000
Elastic limit	30,000	37,500	48,000	50,000	60,000
Elongation	28 p. c.	23 p. c.	23 p. c.	25 p. c.	25 p. c.
Contraction of area	50 p. c.	40 p. c.	50 p. c.	50 p. c.	60 p. c.

In naming the above qualities in tempered material the sectional thickness is assumed to be considerable, say 3 inches and above; when the thickness is reduced to, say, 1 to 1½ inches the elastic limit of simple steel can be raised to about 55,000 to 60,000 pounds, and of nickel steel to 65,000 or 70,000 per square inch, without reducing the ductility.

Painting Freight Cars by Compressed Air.

The economy of compressed air in painting railway equipment was discussed at the February meeting of the New England Club. Mr. D. W. Smith, Wellsville, O., stated that by its use the body and roof of a 34-foot box car can be given its first coat in 24 minutes, its second coat in 20 minutes, and that a gondola car body, with 44-inch sides, can be painted in 10 minutes for each coat. He also said that the apparatus used less material than painting by hand, and that the operator has complete control of the flow of paint and can apply a heavy or light coat as desired. Mr. C. E. Copp had seen four kinds of painting apparatus, and while without extended personal experience with any of them, he believed that the use of compressed air for applying paint to freight equipment was bound to become general. He also gave 10 minutes as the time required to paint a coal car body. He said that in the open air in cold weather trouble had been experienced with ice in the pipes and valves, and to remedy this warming of the air has been considered. The paint also has a softening action on the interior of the hose, which difficulty must be overcome. He believed the paint was worked into the pores of the wood better than if applied by hand. Mr. Quest, of the P. & L. E. Railroad, gave the following estimated cost of work done in his company's yard as compared with painting by hand under the piece-work system:

	Piece work.		With spray.		Saving.		
	Hours.	Cost.	Hours.	Cost.	Hours.	Cost.	Per cent
Box	3½	.60	¾	.15	2¾	.45	75
Coal	1⅙	.30	¼	.10	1¼	.20	66⅔
Coke	3	.50	⅛	.12	2⅛	.38	76
Flat	⅓	.10	1/16	.05	⅓	.05	50
Trucks, all cars	.....	.30	....	.12	.....	.18	60
Roof only, box cars	.....	.10	.....	.04	.....	.06	60

Mr. J. H. Kahler, of the Erie Railroad, has had two spraying nozzles and 200 feet of one-half inch hose in operation for two years, and he believes thoroughly in the method. It not only saves time, but gets the paint into corners, angles, tongues and grooves, etc., better than by hand. Mr. G. H. MacMasters gives the following comparison of the old and new methods:

Priming new 35-foot box car by hand—		
Labor, 2 hours, at 20 cents	$0.40	
Material, 14 pounds paint, at 5 cents	0.70	
Total		$1.10
Priming new 35-foot box car with spraying machine—		
Labor, 35 minutes, at 20 cents per hour	$0.12	
Material, 12 pounds, at 5 cents	0 60	
Total		$0.72
Total saving of		$0.38

Or 34.57 per cent.

Saving of labor painting by spraying machine, 28 cents, or 70.83 per cent. Saving of material painting by spraying machine, 10 cents, or 14.29 per cent. Roof and trucks not included.

As for the apparatus, that employed on the P. & L. E. Railroad seemed to meet with the greatest favor, though others are mentioned in the proceedings. Mr. Hodge, of the Santa Fe, presented drawings of the apparatus used by him. The Bryce Pneumatic Paint Machine was also mentioned.

Details of the Compound Mastodon Locomotives for the Northern Pacific Railroad.

Last month we published a full-page engraving and a description of the large compound mastodon or 12-wheeled engines built for the Northern Pacific Railroad by the Schenectady Locomotive Works. We have since received from the builders several detail drawings, some of which we reproduce herewith.

From their great size the cylinders are of more than ordinary interest. The low-pressure cylinder and half saddle are shown in Fig. 1, and one view of the high-pressure cylinder is given in Fig. 2 (p. 124). The latter cylinder is 23 inches in diameter and 30 inches stroke, and is supplied with steam at 200 pounds' pressure. Its ports are 20 inches long. The low-pressure cylinder is 34 inches in diameter and 30 inches stroke, and its ports are 23 inches long, the admission ports being 2½ inches wide, and the exhaust 3 inches wide. The difficulties encountered in finding room for such a large cylinder are illustrated by the method adopted for bolting it to the frames. The cylinder centers are 86 inches apart, and the frame centers are only 45½ inches, and yet the bore of the cylinder is only 2¼ inches away from the frame at its nearest point. It was therefore impossible to follow the usual practice of passing the horizontal bolts securing the cylinder to the lower rail of the frame through a flange on the cylinder casting extending down the outside face of the frame.

The expedient was resorted to of drilling the bolt-holes completely through the wall of the cylinder, counterboring on the inside for the boltheads, and putting the bolts in from the inside. There are seven bolts inserted in this manner, a detail of which is given in Fig. 1. The heads are round, with a circular groove in each, and they are tinned before being put in place. When in position babbitt is poured around the heads and the metal finished off smooth with the bore of the cylinder. This is a novel method of securing a cylinder, but we understand that it has been used before with entire success either by these builders or by the Richmond Works.

The cylinders are made very strong throughout, and the fastenings to the frames and the boiler are substantial. The exhaust is partly in one half-saddle and partly in the other. The joint between the two castings is made steam tight by a thickness of varnished paper.

The intercepting and separate exhaust valves are of comparatively new designs recently perfected by Mr. A. J. Pitkin, Vice-President and General Manager of the Schenectady Locomotive Works, and Mr. J. E. Sague, Mechanical Engineer for the company. They are designed to give an independent exhaust to the high-pressure cylinders when the locomotive is working as a simple engine, and also to give the engineer control of the intercepting valve so that he can operate the engine simple or compound at will. In Fig. 3 a longitudinal section through the valve shows the parts in the position they assume when the engine is working simple, and in Fig. 4 a similar section shows the parts in the position for working compound. With the arrangement of valves shown

in these figures, the engine can be started and run either compound or simple, and can be changed from compound to simple or from simple to compound at the will of the engineer, with any position of throttle, and at any point of cut-off. The part which each valve does in accomplishing this is as follows:

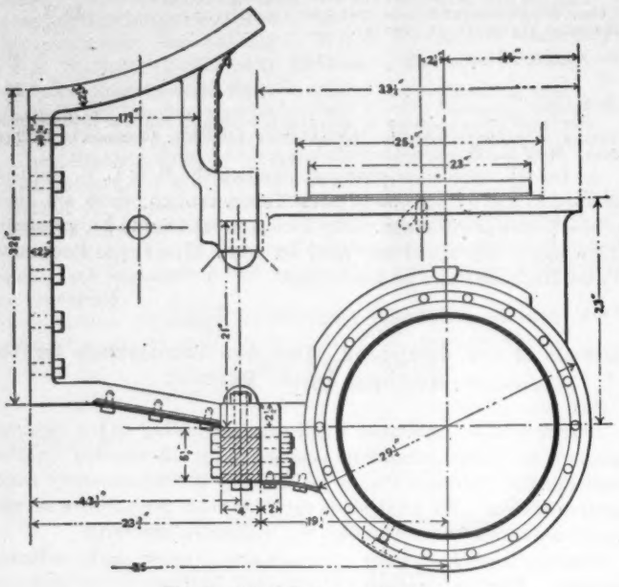


Fig. 2.—High Pressure Cylinder.

The separate exhaust valve when open allows the steam to exhaust direct from the high-pressure cylinder to the atmosphere without going through the low-pressure cylinder, thus working the engine simple, and when closed, causes the steam from the high-pressure cylinder to go through the low-pressure cylinder, thus working the engine compound. The intercepting valve closes the passage between the cylinders when the separate exhaust valve is opened, so that steam connot go from the high-pressure cylinder to the low-pressure cylinder, and it admits steam to the low-pressure cylinder direct from the dry pipe through the reducing valve. When the separate exhaust valve closes, the intercepting valve opens the passage between the cylinders and cuts off the supply of steam from the dry pipe to the low-pressure cylinder.

The reducing valve works only when the engine is running simple, and throttles the steam passing through it, so that the pressure of steam going to the low-pressure cylinder is about one-half the steam pressure in the dry pipe.

The intercepting and reducing valves are worked automatically by the steam pressures acting on the difference of areas of the ends of the valves, and their movement is cushioned by dash pots. The separate exhaust valve is operated by the engineer, by means of a three-way cock in the cab. To open the separate exhaust valve, the handle of the three-way cock is thrown so as to admit air or steam pressure against the piston *J*. Pulling the handle back relieves the pressure against *J*. and the spring, which is shown in the figures, shuts the valve. All the engineer ever has to do in connection with the operation of the valves is to pull the handle of a three-way cock in the cab, one way or the other, according

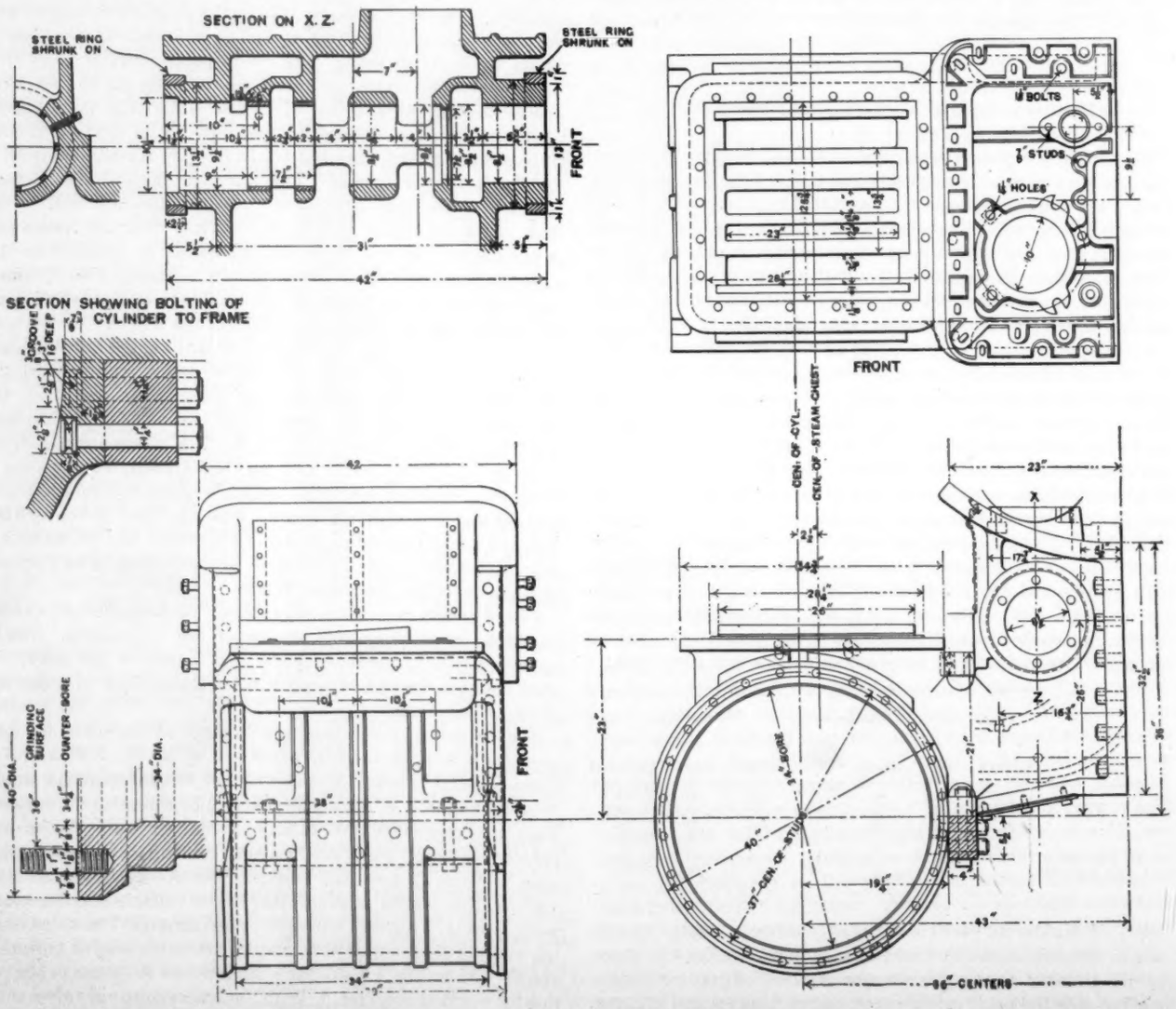


Fig. 1.—Low Pressure Cylinder of Compound Mastodon Locomotive.

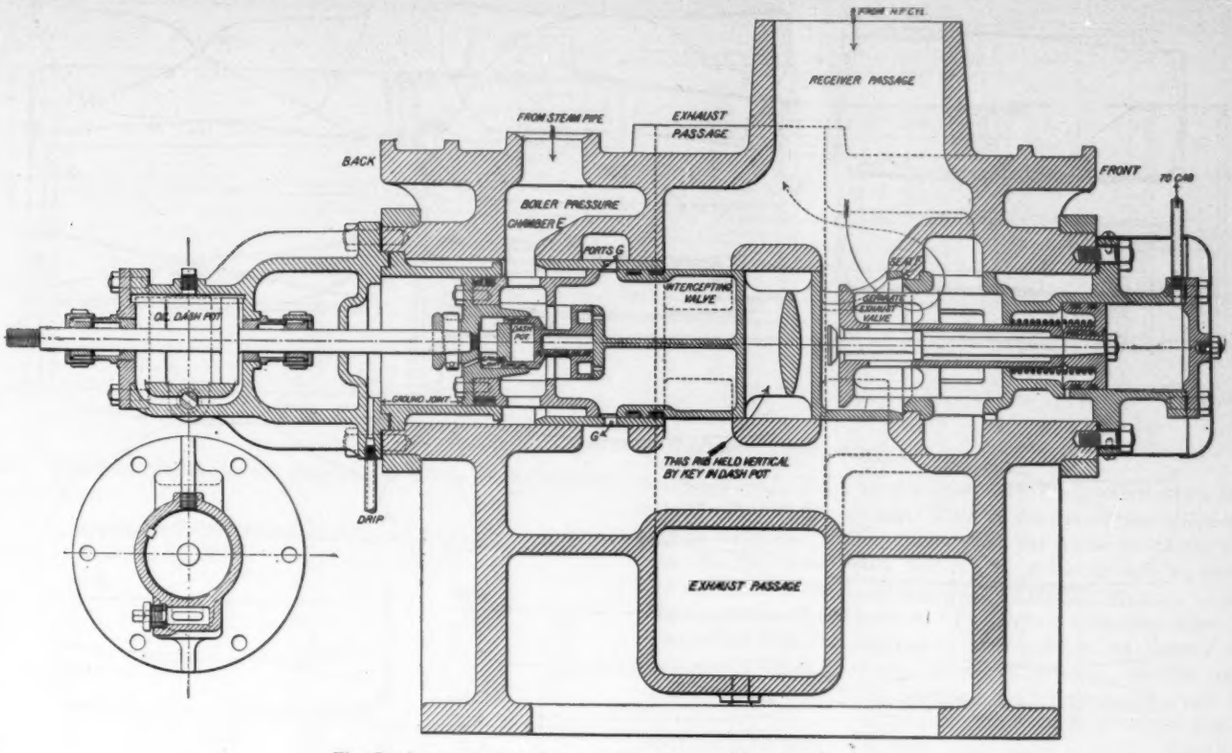


Fig. 3.—Intercepting Valve in Position of Simple Working.

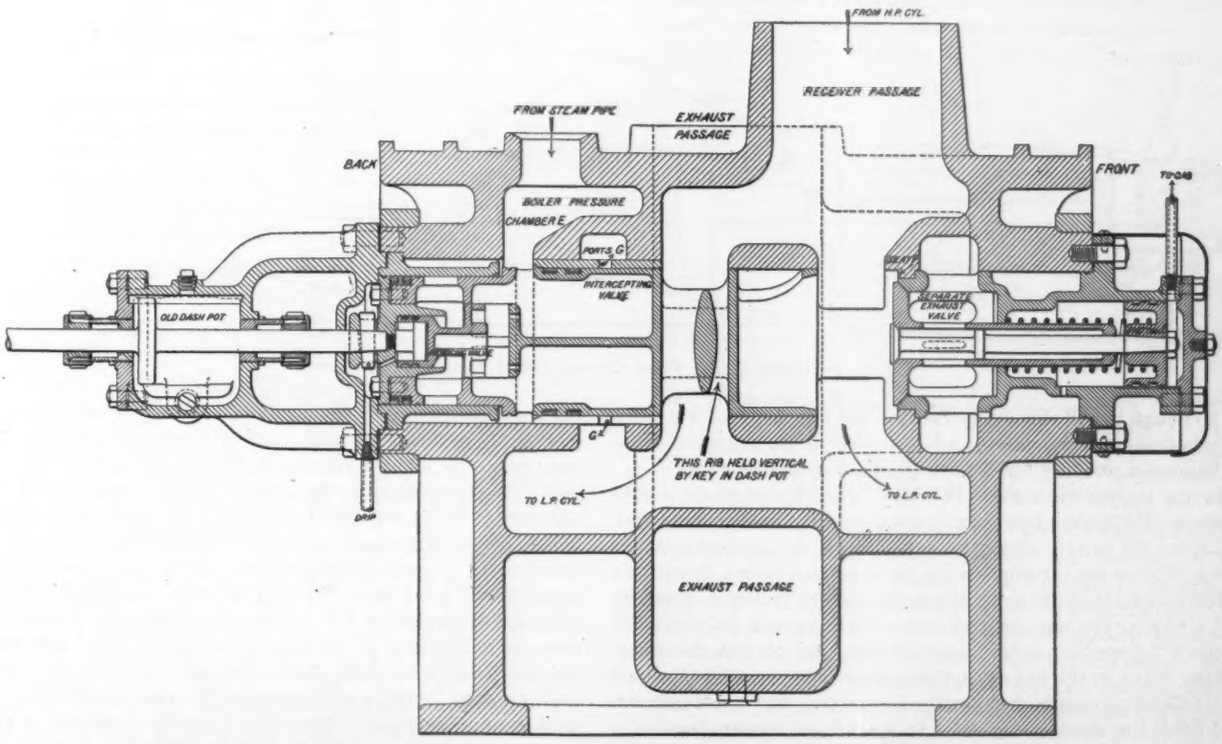


Fig. 4.—Intercepting Valve in Position for Compound Working. Schenectady Locomotive Works.

as he wishes the engine to run simple or compound. The engineer uses this handle under the following conditions:

First, to start simple. Under ordinary conditions this is not necessary, but if the maximum tractive power of the engine is to start a heavy train, the engineer pulls the handle of the three-way cock so as to admit pressure on the piston *J*. This will force the piston *J* into the position show in Fig 3, which opens the separate exhaust valve and holds it open, As soon as the throttle is opened, steam at boiler pressure enters the chamber *E* and forces the intercepting valve against the seat *F*, as shown in Fig. 3. Steam enters the high-pressure cylinder, and is exhausted through the receiver pipe and separate exhaust valve to the atmosphere, as shown in Fig. 3. Steam also enters the low-pressure cylinder from chamber *E*, through the reducing valve and ports *G*, and is exhausted in the usual way. The steam is prevented from reaching the low pressure cylinder at boiler pressure by going through the reducing valve. As will be seen from Fig. 3, the valve is partly balanced by the cylinder open to the atmosphere, and the boiler-pressure acting on the unbalanced area throws the valve to the right. When the pressure on the right of the valve becomes

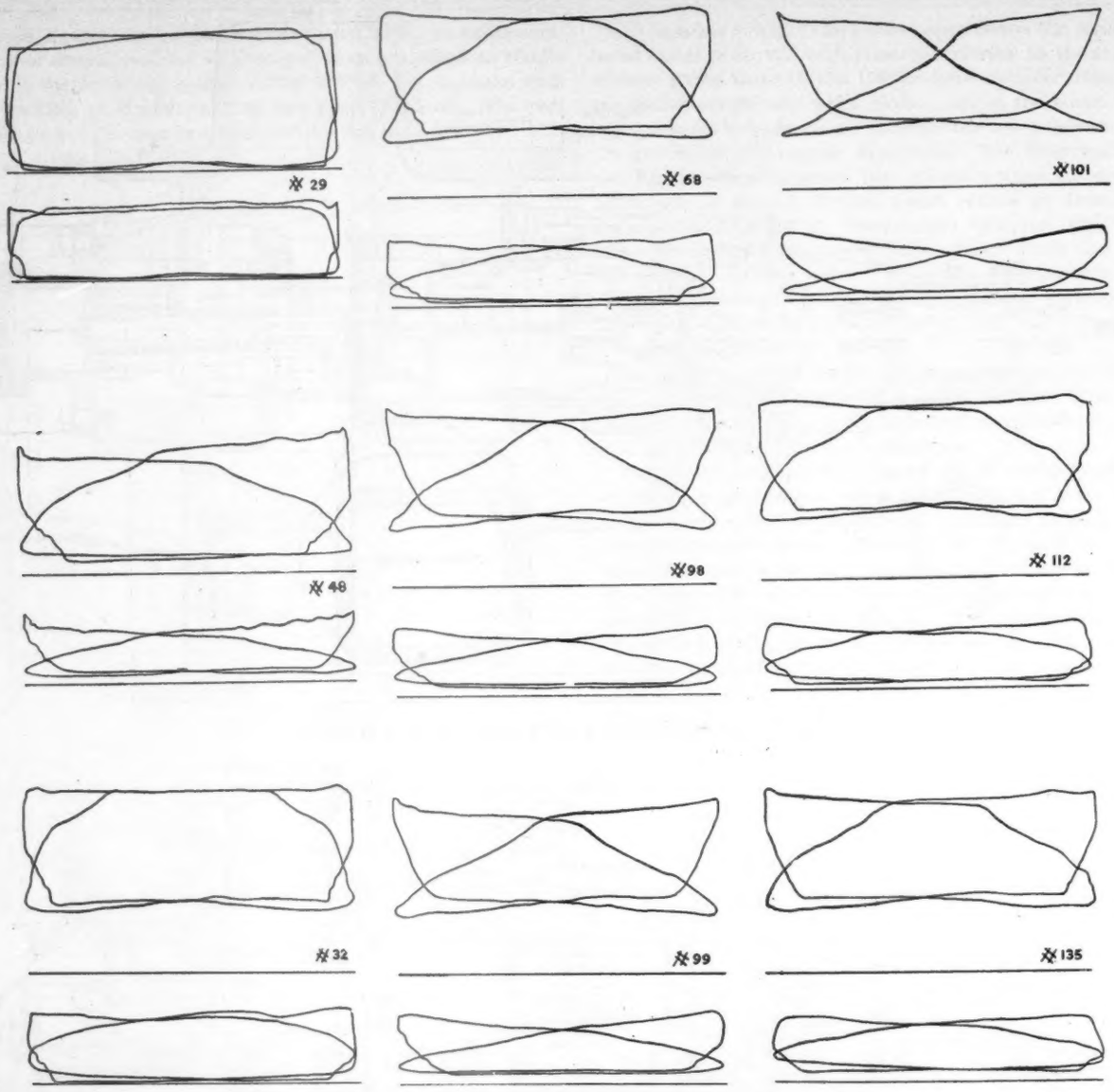


Fig. 5.—Indicator Cards From Compound Mastodon Locomotives.

high enough it will throw the valve to the left, because it acts on the whole area of the valve, and in so doing throttles the steam to the proper pressure for the low-pressure cylinder.

Having started the train in this way, when the engineer wishes to change the engine from running simple to running compound, he pushes the handle of the three-way cock to its first position, which relieves the pressure on the right of the piston *J*, and the spring throws that piston to the right into the position shown in Fig. 4, closing the separate exhaust valve. As soon as this valve is closed the pressure in the receiver rises and presses the intercepting valve to the left against the pressure in chamber *E*, which only acts as an unbalanced area of the valve. The receiver pressure holds the intercepting valve to the left, as shown in Fig. 4, closing the ports *G* and opening a free passage from the high-pressure cylinder to the low-pressure cylinder, and the engine works compound.

It will be noticed that, while working compound, which is the usual way of working the engine, the intercepting and reducing valves are both held against ground joint seats which prevent the leakage of steam that may have leaked past the packing rings.

Now with the engine running compound, if the engineer wishes to run the engine simple, because of a heavy grade, he pulls the handle of the three-way cock the same as for starting simple. This will open first the by-pass valve *K*, and then the separate exhaust valve, the by-pass valve relieving the pressure more gradually than if the large valve was opened at once. As soon as the separate exhaust valve is open the pressure in the receiver drops, and the intercepting valve is forced against the seat *F* by the pressure in chamber *E*, and the engine runs simple as before. When the grade is passed the engineer pushes the handle of the three-way cock over and the engine begins to work compound. To start the engine compound the separate exhaust valve is left closed, as in Fig. 4, and when the throttle is opened the intercepting valve will be forced against the seat *F* by the pressure in chamber *E*, as shown in Fig. 3. The low-pressure cylinder will then take steam through the ports *G*, and the high-pressure cylinder will exhaust into the receiver for a few strokes of the engine. This will raise the pressure in the receiver and force the intercepting valve into the position shown in Fig. 4, closing the ports *G*, and the engine will run compound.

The combination of the automatic intercepting valve with the separate exhaust valve permits the engine to be changed from simple to compound, and the reverse, very smoothly and without danger of jerking the train, and in recent tests the engine was changed from compound to simple and the reverse repeatedly, when operating at a maximum power, with the throttle remaining wide open.

When the first of these four engines were built it was given a trial trip on the tracks of the New York Central road. Going out of Schenectady there is a 60-foot grade to surmount, and in Fig. 5 we show a number of diagrams taken from the engine on that

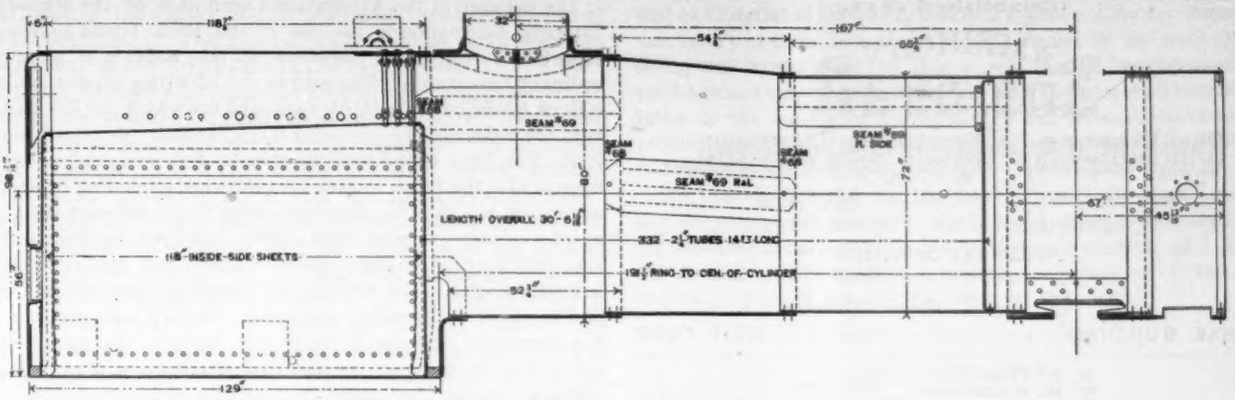


Fig. 6.—Boiler for Compound Mastadon Locomotive.

grade. The data relating to the diagrams is given in the accompanying table:

DATA FOR INDICATOR DIAGRAMS GIVEN IN FIG. 5.

No. of card.	Revolutions per minute.	Miles per hour.	Piston speed in ft. per min.	Steam pressure.	Horse power.	Per cent. of work done by L. P. cyl.	Position of throttle.
29	20	3.3	100	200	349	54.1	⅛ open.
48	90	14.7	450	200	960	49.6	½ "
32	56	9.1	280	200	818	55.1	wide open
68	64	10.4	320	201	785	51.2	¾ open.
98	102	16.7	510	200	1,015	54.0	wide open.
99	118	19.3	590	195	1,097	55.7	" "
101	114	18.6	570	195	904	56 7	" "
112	86	14.1	430	195	1,001	52.0	" "
135	112	18.3	560	195	1,220	52 0	" "

It should be noted that diagrams 29 and 48 were taken while the locomotive was working as a simple engine. All the diagrams are of interest as being taken from what is probably the largest pair of compound cylinders thus far introduced into locomotive practice. The enormous power of the engine can be realized when it is noted that at a speed of only 18.3 miles per hour it indicated 1,230 horse-power. The tractive effort at the rail in this case (card No. 135) can be calculated thus:

$$\frac{33{,}000 \times 1{,}230 \times 60}{5{,}280 \times 18.3} = 25{,}125 \text{ pounds,}$$

from which must be deducted the engine friction, which, if taken at 12½ per cent. of the total power, leaves a tractive effort at the rails of about 22,000 pounds. This is enormous for a speed of over 18 miles per hour. Performing the same calculation for card No. 29, taken with the engine working simple, and we find the tractive effort, after deducting engine friction, to be in round numbers 35,000 pounds. This figure indicates what may be expected from this engine at slow speeds, as shortly after starting, or when working on heavy grades. As the weight upon the drivers is 150,000 pounds, it is interesting to note that the ratio between that weight and the tractive effort at the moment the card referred to was taken was 4.14 to 1. This figure ought to interest one of our English contemporaries, who assumes a ratio of 6 or 7 to 1, and then cannot understand why American locomotives can exert such large tractive offorts.

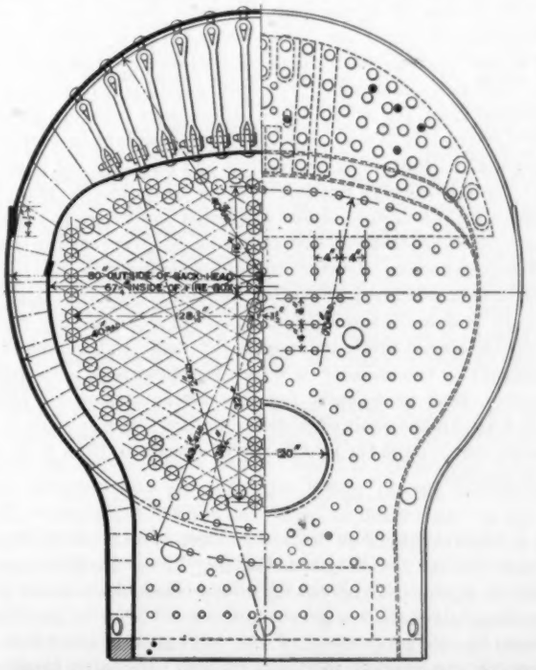


Fig. 7.—Boiler for Compound Mastadon Locomotive.

Though we do not illustrate the frames of this engine, a few facts regarding them may not be out of place. They are 4½ inches thick throughout, except at the cylinders and forward of them where the thickness is 4 inches. The top rail is in general 4 inches deep, and the bottom rail from 2½ to 3½ inches deep. Over the driving boxes the top rail is 5½ inches deep and the pedestals are closed at the bottom by thimbles and 2¼-inch bolts. At the cylinders the top and bottom rails are separate forgings, each 5½ inches deep. Just back of the cylinder saddle there is a spacer between then 22½ inches long.

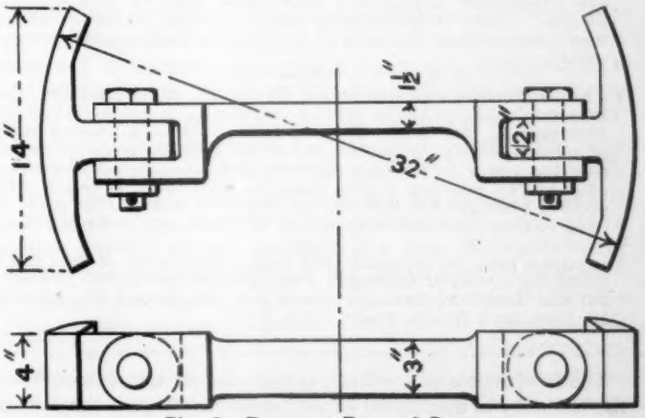


Fig. 8.—Brace at Base of Dome.

The boiler, shown in Figs. 6, 7 and 8, is notable chiefly for its great size and the high pressure carried—200 pounds. It is of the extended wagon-top, radial-stay type, and though nominally 72 inches in diameter, is in reality 80 inches in diameter for considerably more than one-half of its length. For particulars regarding heating surfaces, etc., we refer our readers to our article last month. The staying of the boiler conforms to modern practice for this type. We would, however, call attention to the manner in which great strength is secured at the base of the dome. In addition to the modern custom of using a very heavy ring flanged both ways at the base of the dome, there is a heavy cross-tie (see Figs. 6 and 8) extending across this ring to prevent any deformation at this point—a wise precaution in view of the large diameter of the boiler at that point and the high pressure carried.

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The brief article on another page of this journal is illustrative of the tendency to use higher carbon steels in forgings, plates and other forms in which the material is employed in machine construction and structural work generally. Undoubtedly this movement is to be commended. In the earlier days of steel it was considered unreliable and mysterious in its action, and one of the greatest safeguards against sudden fractures was supposed to be a low tensile strength and the accompanying great ductility. It is now known that careful working from the moment the ingot is cast until the product is finished is necessary to secure sound material, and that this being obtained the chemical composition can be safely made such as to secure the desired tensile strength for any given case. Engineers are also beginning to understand that the methods of obtaining the elastic limit have in the past been faulty and that in many cases the true elastic limit is considerably less than the figures which have been used by them in determining the strains to which the material will be subjected. The belief is, therefore, growing that higher carbon steels with their greater ultimate strength and higher elastic limit are better for many classes of work than those soft steels the elastic limit of which is so low that either the strains which they are to endure must be smaller than is economical or the danger of occasionally exceeding the elastic limit will become too great. In other words, a good high carbon steel with a large actual factor of safety is better than a low carbon steel with a smaller factor of safety.

The decision of the Arbitration Committee of the Master Car Builders' Association in the case of the Rock Island against the Lake Shore road, found elsewhere in this issue, is of more than ordinary importance. The case is one of wrong repairs made on a Rock Island car by a third road, and for which the Rock Island held the Lake Shore responsible when the latter delivered the car to it. The Rock Island held the opinion that, as a road was called upon, under the rules, to give the same care (including inspection) of foreign cars as of its own, such inspection is the only safeguard against wrong repairs that have not been carded, and an intermediate road failing to discover the wrong repairs should be held responsible. The Arbitration Committee also held this view, and so ruled. This ruling appears to be both wise and just, but it nevertheless institutes an inspection that is not for safety alone, and to that extent is in conflict with the spirit of the new interchange. On the other hand, it must not be forgotten that there is a vast difference between "inspection for protection," which dealt with a thousand and one small matters that arose through honest differences in the interpretations of the old rules, and an inspection which, after safety, seeks only to guard against the carelessness of those who make wrong repairs and do not card for them.

A very strong argument in favor of a more exact determination of the elastic limit in testing steel is given by Mr. P. Kreuzpointer in recent issues of the Iron Age. Three definitions of the term elastic limit must be borne in mind, viz., the load which does not produce permanent set, the limit of proportionality of stretch, and the visible limit at which a visible stretch takes place without a noticeable increase of load, and which shows itself by the drop of the beam of the testing machine. The difference between the visible elastic limit and the limit of proportionality is of vital importance, for when the latter figure is exceeded in service, it is apparent that the material is already undergoing structural deterioration and must be relieved of strain or it will ultimately fail. Tests are quoted to show that in 84,000 pounds steel this limit of proportionality was as much as 6,900 pounds less than the visible elastic limit. In another case it was 6,200 pounds. In some tests of iron it was 1,500 pounds. Tests made by Professor Bauschinger on 1-inch round iron showed an average difference of 6,775 pounds per square inch, one piece rising to 8,750 pounds. On Bessemer steel he found that with an average visible elastic limit of 39,000 pounds the limit of proportionality was 4,980 pounds less. This average is made even more significant if we look at the individual tests, for we find the differences ranging all the way from 1,300 to 12,400 pounds. Thus if we attempt to employ steel with a visible limit of 40,000 pounds and its limit of proportionality (though we may not know it) is only 28,000 pounds, it is evident that the metal may be subjected to stresses too great and these may be repeated so frequently as to give insufficient time for elastic reaction. Under such circumstances failure is certain. At all events it is clear to every competent engineer that safety lies only in definite knowledge, and such an indefinite figure as the visible elastic limit, inaccurate in itself, and rendered more inaccurate by the manner in which it is obtained, can never be as safely used as a basis for the determination of allowable stresses as can the limit of proportionality. The subject is so important that it calls for much more attention than it is receiving at present.

In a valuable paper on lead for locomotives read by Mr. C. H. Quereau before the Western Railway Club, in February, some excellent reasons are given for abandoning the present practice of setting valves with a given amount of lead in full gear, regardless of the proportions of the valve gear or the steam distribution at the average working cut-off. Probably there are almost as many differences in opinion to-day regarding valve setting as in times past, and even among those who advocate reduced lead at the running cut-off several methods of accomplishing the result are advocated. But the unanimity on the advantages of reduced lead is significant. The different methods consist in getting the reduced lead at the working cut-off either

by (1) setting the valves in full gear with equal leads in front and back motion, (2) with more in the front than in the back, or (3) with less in the front than in the back motion. The author states that "careful experiments with full size valve-gear models, plotting the results enlarged eight times, shows that with a given valve gear the steam distribution for 6-inch cut-off is the same so long as the lead for that cut-off remains the same, no matter in which way the full gear lead is set." The different methods of setting do, however, affect the power at intermediate points of cut-off, and the author is of the opinion that "it is better to make the full gear lead for forward motion either line and line or slightly negative. In my opinion it should never be more than 1-16 inch positive for a plain valve or 1-32 inch positive for an Allen valve, and less than these amounts will increase the power of the engine. When the proportions of the valve gear are such as to allow the correct lead for the running cut-off and at the same time secure a full gear lead not greater than 1-16 inch positive or less than 1-16 inch negative for plain valves, nor greater than 1-32 inch positive or less than 3-32 inch negative for Allen valves, I would prefer to make the full gear lead the same in both front and back gear. Except in rare cases where the link radius is excessively long, the third method has no special advantage, and is probably objectionable because it reduces the port opening for cut-offs longer than 6 inches more than is desirable. Where the radius of the links is less than about 50 inches, and the engines do most of their work in forward motion, the second method is probably the best." The essence of the matter seems to be that if one will set valves with the idea of getting the right lead at the working cut-offs, a distinct advantage in smooth working, increased power and even economy of coal will result; furthermore, that if this calls for negative lead, no harm will result; and lastly, that any of the three methods of valve setting in full gear may be found best under special conditions, but that the second method is preferable for the average locomotive.

PIECE WORK PRICES.

In conversation recently with a prominent superintendent of motive power the question of piece work came up, and he objected strongly to the practice of some officials who before introducing it in their shops send to other roads for their price lists. The official refered to has no objection to making public the prices paid in his shops, but he has found that often such prices are an incentive to others to "go one better" regardless of the normal prices of labor in the two places. This is wrong and if persisted in will only bring piece work in bad repute. In deciding upon the prices to be paid by the piece each shop must take into consideration the prices for labor in the market from which it gets its supply. All other things being equal the piece work price for planing a crosshead should not be the same in a shop located where good machinists get 30 cents per hour as in a shop where 22 cents per hour would be a fair price. If they were the same, either the men would be getting too much in one case or the company would be getting too much in the other.

It is conceivable that the piece work prices in a locality where labor is high may be more than the cost of similar work by the day plan in communities where labor is cheap, but that has nothing whatever to do with the fixing of just and equitable prices in either place. Each case must be dealt with on its own merits. Granted that a shop heretofore operated on the day plan has been run economically, and that piece work is now contemplated, the prices should be so adjusted that the company and the men will each profit by the change, and to about an equal degree. When this has been done the men will be satisfied, and the company *should* be satisfied regardless of what somebody else pays for similar work. Further economies will be achieved, but they will come from the introduction of improved machinery and methods. One shop which we have in mind has the excellent rule that when the price for a certain piece of work has once been established to the satisfaction of all concerned, the company will make no change in it one way or the other, unless it changes the shape, size or material of the piece, makes a capital outlay for improved machinery or tools, or makes a radical change in its methods of doing the work. Add to this a rule that all improvements in methods and machinery originating with the men shall benefit the latter to the extent of giving them a fair share of the resulting profits, and it would appear as if the company had enlisted all its forces in the interests of economy.

But to go back to the starting point, if somebody else's practice and prices are used as a guide, see to it that due allowance is made for the differences in machinery, in the labor market, and in all that is necessary to consider in arriving at prices fair to the men and the company.

ROLLER BEARINGS.

The present time appears to be marked by another period of activity in the development of roller bearings for such trying work as steam and street railway work. It is within the realms of possibility that some day a successful roller bearing for that work may be found, but we feel that many who have hopes in this direction do not stop to fully consider the difficulties in the way.

The advantages of roller bearings over present practice are supposed to lie in the substitution of a rolling for a sliding contact, with all the attendant benefits of reduced friction, and absence of lubrication and wear. The theory is beautiful, but the construction of a practical bearing is another matter. Two almost insurmountable difficulties appear at once; one is to keep the rolls parallel to the journal so that the theoretical line of contact be not reduced to a point, and the other is to so space apart the various rolls as to prevent them from rubbing on each other. It may be asserted, without fear of contradiction, that seldom has a roller bearing been designed in which these requirements were met without introducing sliding contacts somewhere in the structure. Some bearings have been designed in which the main rolls were spaced by secondary rolls which also had a rolling contact on a fixed part of the box in which the main rolls revolved. But it is evident that in such a design there is nothing to resist any tendency of the rolls to get out of parallelism with the journal. In fact, they might all stand at an angle to the journal and be parallel to each other. Not only is it possible for them to get into this position, but they actually get there, and then the end thrust of each roll causes trouble (for such end thrust is generally resisted by sliding contacts), and it is furthermore evident that the purely rolling contact between the rolls is converted into a mixed sliding and rolling contact, while the contacts on the journals are mere points, not lines. Again, as the journal, rolls and box wear (for they do wear), the general looseness of parts permits the evils mentioned to increase rapidly. Then we have enough grinding and cutting of parts to spoil all the fine friction records which bearings furnish when new.

Other bearings have been designed in which the spacing of the main rolls has been attempted with a view of also keeping them parallel with the journal, In such cases the spacing mechanism has usually been carried by what has been called a "cage," consisting of two rings between which the main rolls run, and which are riveted together by studs long enough to give the rolls some end motion between the rings. The rolls are generally guided in the straight path of duty by secondary rolls, which, in turn, are held in line by an arrangement which involves sliding friction among these parts. We once had some experience with a bearing of this class, which made more than 100,000 miles under a 55,000-pound coach, and while the main rolls behaved in a creditable manner when new, the secondary rolls wore rapidly. When worn so much as to fail in their duty of guiding the main rolls, the latter would seek devious ways, and act in total disregard of all the good things their owner had said about them. We have known one-half an inch to be worn off the end of a roll 3¼ inches in diameter, in a few hundred miles, and the other rolls in the same box to be not far behind that record. These boxes were supposed to run be without oil, for that was one of the economies claimed for them, but the parts were always soaked in oil when

first fitted up, and when end wear of the rolls appeared they were invariably treated to a dose of graphite.

Any good mechanic who studies the requisites of a good roller bearing will recognize the need of keeping the rolls absolutely in line. To do this he will see that the main rolls will need to be held either by rolls or balls. If rolls, then these in turn must be kept in line by other rolls or balls, and so on indefinitely, if sliding friction is to be avoided. Furthermore, adjustment for wear must be provided, even if balls are used in place of secondary rolls. Then, while the end thrust of the axle can be taken care of independently of the rolls, the bodily lateral movement of the latter must be prevented. After all this has been done, we will have a device that rivals a clock in the accuracy of workmanship, and in which there are many points where sliding friction or imperfect adjustment will get in their insidious work.

What we have said against the practicability of roller bearings is meant to apply only to heavy pressures and high speeds. Evidently, under such conditions, all defects are exaggerated and the greatest accuracy of alignment is necessary. For many other purposes roller bearings might be made a success. A roll made out of square steel wound in helical form, brought out some years ago, has a flexibility which ought to make it very satisfactory for uses to which rollers are really adapted. When the alignment in the bearing is not perfect, either because of workmanship or wear, the bearing of such a roll is not a mere point, but continues to be a line under all ordinary conditions, and the material is well adapted to resist cutting and any tendency to excessive wear.

COMPRESSED AIR AND ELECTRICITY.

At the June Convention of the Master Mechanics' Association, a report is expected on the subject of motors for shops—steam, air and electric. The practical abandonment of steam motors for all purposes outside of the main power plant is so general that we may expect the report to be largely devoted to compressed air and electricity. It is an interesting subject and if the committee will realize that there is a field for each of these types of motors and will as far as possible define those fields, a valuable work will have been accomplished. To an impartial mind, both compressed air and electricity appear as valuable agents for the transmission of power. Both have the advantages of small loss in transmission and of conductors at the temperature of the surrounding atmosphere and suitable for almost all places and positions. In the storage of power compressed air appears to have an advantage over its competitor. When, however, we come to utilize the power transmitted we are at once confronted with the fact that electricity can be used satisfactorily only where a rotary motion is suitable to the work in hand, while the forte of compressed air is not rotary but reciprocation motion. The relative values of the two agents consequently depend not altogether upon the methods or economy of generating and transmitting the power by each, but somewhat upon the facility with which each can be employed at the various points and to the work for which the power was generated. Under these circumstances it would appear almost axiomatic and entirely beyond dispute that each of these agents has its legitimate field. At present there seems to be a disposition on the part of the advocates of each to urge the use of one to the exclusion of the other, but we venture the prediction that in the near future large shops will be equipped with both electricity and compressed air for power purposes. Why not? This present hustling after compressed air tools, much as it is to be commended, does not arise from the fact that it is superior to all known agents for all purposes, but because it is much cheaper than the manual labor it replaces; in fact, the cases are legion where compressed air is generated and used in a thoroughly wasteful fashion, and yet saves much money when compared with former methods involving more manual labor. When we get far enough into the new order of things to be more concerned in how much more we can save than in the good work already done, the wasteful methods of using air will not be tolerated, and where the use of electricity is the proper solution for individual cases, that agent will surely be employed. Then we will find electric generators and air compressors both installed in the one plant, and each time it is decided to employ power for certain operations formerly done by hand, the agent more suitable for that particular case will be selected. Such a course will not result in reducing the extent to which compressed air is used, for the employment of both air and electricity are bound to extend greatly as the result of the ever pressing demand for economy in shop operations.

RAILWAY ENGINEERING.

We publish elsewhere the courses and lectures in railway engineering which Purdue University offers for the year beginning in September, 1897. We call particular attention to it because in our opinion it embodies the only practical method by which our universities can meet the demand for a special technical training for young men who intend to engage in the "railway profession;" not that this excellent course thus outlined is wholly perfect, but because it is based upon a right conception of how the technical training mentioned shall be given, and because it represents the best judgment of a university faculty that has done more in providing opportunities for railway technical education than any other.

If ever some of the special courses suggested by several writers, which apparently aim to give young men the general knowledge required to fit them for positions of managers and presidents, are undertaken we believe they will fail. Men are not fitted for positions of responsibility in that manner. On the contrary, almost every man of high position has prepared for his present duties by labors in one of the several departments he now controls. He leaves his narrower field for a broader one, because in his administration of the affairs of one department he has exhibited an executive ability and a breadth of view that has enabled him to make that department part of one harmonious whole. Specially trained in one line of work, he has taken a comprehensive view of railway operation as a whole and understands the sphere of each department and its proper relation to the others. Able men of that stamp can advance from the special work, whether that be traffic, civil or mechanical engineering, or anything else, into broader fields of usefulness, and that, too, without a general collegiate education for the "railway profession." In fact, we believe that courses such as Purdue has outlined, particularly if so administered as to lead the student at each step to see the relation of his own chosen calling to the other professions and to the great commercial and industrial enterprises of the times, furnish the best of educations to men destined to occupy advanced positions. We are reminded of the case of a civil engineer of prominence who, in middle life, found himself at the head of great railway traffic interests, and who confided to an acquaintance his opinion that he was then still following his profession. He found that the training which made him successful as an engineer enabled him to view other business problems from all sides, and that underlying the honest administration of all great interests there were the same general principles.

There is another consideration which must not be overlooked in this connection. No university education, however complete, will ever fit a man for the immediate control of great business interests. He must have practical experience first. Where will he get it? If his education has been along the line of railway management only, will somebody entrust a great property to him while he is getting the practical experience? Is he not more likely to find lucrative employment within a reasonable time after graduation if his education has been along the line of some of the professions with an insight into what we will term administration? We have already stated in these columns our opinion that if the great transportation interests of this country are as great a factor in commercial, industrial and social life as most of us believe they are, we need not the educational courses on railways that will appeal to the few, but rather such courses in every university as will interest the many. We, therefore, welcome the broader work of Purdue in railway engineering as a practical example of this kind, and with the assurance that its excellent record in the past is a guarantee of the quality of its future work,

A NEW RECORD-BREAKING STEAMSHIP.

At last the dimensions of the *Great Eastern*, noted chiefly as being the largest steamship ever built, are to be exceeded by a new trans-Atlantic steamer. The White Star Line has arranged with Harland & Wolff, of Belfast, for the construction of a steamer 704 feet long, which, if this measurement is taken on the water line, is 24 feet longer than the *Great Eastern*, and about 65 feet longer than any of the large steamers now in the passenger service on the Atlantic. The boat will be about 70 feet beam, and its gross tonnage will exceed 17,000. In another respect the new steamer will claim distinction, and that is in the power of its engines. The *Oceanic*, as the boat is to be called, will be propelled by three screws driven by three sets of engines aggregating between 45,000 and 50,000 horse power. The greatest power thus far placed in a steamer is the 30,000 horse power of the latest Cunarders. The enormous increase of power in the new boat is perhaps better realized if we stop to think that it is more than double the power in many of the great boats that are capable of making 21 knots at sea. The development of this power will entail an enormous coal consumption, estimated at 700 long tons per day. This is at the rate of 1.5 pounds of coal per horse power per hour for 45,000 horse power. The ship will have to carry about 4,000 tons of coal when leaving port. It is said the boat is to have a speed of 27 knots.

The steamship company do not claim this speed for the boat however. They say that the attention will be given to the matter of speed, but extreme speed will be subordinated to the comfort and convenience of passengers of all classes; and in her internal arrangements the new vessel will be an enlarged reproduction of the *Teutonic* and *Majestic*, except in so far as improvements may have suggested themselves in the size and fittings of the rooms, and which may be rendered practicable by the increased dimensions of the ship herself. Upon this question of speed the company state that although a much higher sea speed than that now contemplated is quite practicable from an engineering point of view, it has been determined as far as possible to aim at a regular Wednesday morning arrival, both in New York and in Liverpool, making the Irish land and Queenstown by daylight, and enabling passengers who may be traveling to places beyond the port of arrival to proceed to and in the majority of cases reach their destinations with comfort during the day. It is expected that the new *Oceanic* will be launched in January, 1898. Her advent will be regarded with interest. As illustrating her utility to the British Government in case of war it may be stated that in the matter of coal endurance her powers are to be most exceptional, inasmuch as after making liberal allowance for the weights of stores, ammunition and troops, the boat will be able to steam 23,400 knots at 12 knots per hour, or practically round the world without coaling. This great passenger and mail steamer going into service in 1898, and the huge freight steamer *Pennsylvania* of the North German Lloyd, which completed its maiden trip last month, will hardly be exceeded in dimensions during this century so near a close, and may therefore be considered as the greatest triumphs in their respective classes of nineteenth century marine construction.

NOTES.

At the March meeting of the Central Railroad Club a report was made in favor of piecework in railroad shops, including the work of car repairs.

On the 14th of January, 1897, the Society of Civil Engineers of France dedicated its new home in Paris, and in commemoration of the event has published a neat illustrated pamphlet descriptive of the building and giving briefly the history of the society since its organization in 1848.

Mr. Lucien Serraillier has compiled and Messrs. Whittaker & Company, Paternoster Square, London, E. C., will shortly publish a technical railway vocabulary, giving over 5,000 French, English and American technical terms used in railway management, construction and working. The book is destined for the use of engineers, railway men, contractors, company directors, financiers, lawyers, patent agents and inventors.

Government statistics show that during the fiscal year ending June 30, 1896, there were exported from the United States 261 locomotives, 1,750 passenger and freight cars and 14,635 car wheels. Of these, 34 locomotives went to countries on the North American continent, nine to the West Indies, 116 to South America and the remainder to countries beyond the seas; of the cars, 1,461 went to countries on this continent, 126 to the West Indies, 190 to South America and the remainder to countries beyond the seas.

The adoption of the tonnage system for freight trains on the Baltimore & Ohio Southwestern has resulted in quite a saving in the cost of transportation. General Superintendent Rawn states that locomotives, under this system, are pulling from two to seven more loaded cars per train than ever before. A very simple but comprehensive set of blanks has been furnished the Yard Masters, and in making up the trains each locomotive is given the number of tons which it has been demonstrated by experience it is able to haul. This system has also resulted in fewer complaints of locomotives being stalled with their trains on grades.

On the 18th of last month President Depew, of the New York Central road, had occasion to go from New York to Albany on a special train to keep an appointment. He ordered the special at 11:40 a. m. and it started at 12:22. It consisted of an eight-wheeled passenger engine, Mr. Depew's private car and one coach. Once clear of the tunnel and bridge and curves of the lower part of the road, the great race with time began. The 10 miles from Yonkers to Tarrytown were covered in nine minutes, the 30 miles from Spuyten Duyvil to Peekskill were made in 32 minutes, the 45 miles from Poughkeepsie to Hudson were made in 44 minutes, and from Hudson to Albany the 28½ miles were run in 29 minutes. The train arrived at Albany at 2:59, after a run of 143 miles in 156 minutes and 9 seconds. The run was made in four minutes less time than the schedule of the Empire State Express.

Last month we briefly referred to the special run made on the Chicago, Burlington & Quincy road from Chicago to Denver, Feb. 15. Particulars were received just as we went to press last month, from which it appears that the special was requested by wire from Fort Wayne by Mr. H. J. Mayhan, who was traveling on the Pennsylvania limited. The message was received at 8 a. m., but no arrangements were made until Mr. Mayhan arrived at about 9:15 a. m. Only two engines were in the roundhouse at the time, and the one taken was a light 17 by 24 that had been doing duty in suburban service. The train left at 10 o'clock, and without any special arrangements began its long run of 1,025 miles. The train men were instructed to make good time, but were given no record-breaking instructions. A total of 21 station stops were made on the run, consuming 64 minutes, besides 14 other stops made for railroad crossings. The actual time for the entire distance was 18 hours and 53 minutes, or an average of 54.27 miles per hour; deducting the station stops only, the running speed was 57.53 miles per hour. The single private car of which the train consisted weighed 72,000 pounds.

Those who remember the machine for dressing car wheels that was exhibited some five or six years ago in Chicago and was commonly spoken of as the Miltimore car-wheel dressing machine will be interested in a recent paper before the Canadian Society of Civil Engineers, in which several improvements on the machine are described. The machine, as exhibited some years ago, employed two large steel disks, whose rims were turned to the reverse of the standard flange and tread gage of the Master Car Builders' Association, and these were made to revolve at a very high speed, 3,000 revolutions per minute. When brought in contact with a pair of car wheels to be trued up, the latter being made to revolve slowly in the machine, the metal was quickly removed by friction and heat. One great trouble with the arrangement was that it required about 200 horse-power to operate it. From the paper alluded to, it appears that electricity has since

been employed for locally heating the wheel while being dressed, thus making it possible to reduce the power applied to the disks to that necessary to remove the metal already heated. The total power consumed has by this means been reduced somewhat, but hardly enough to bring the machine within the range of commercial success.

Within the past few days the Receivers of the Baltimore & Ohio road have prepared a statement of expenditures from March 1 1896, to Feb. 1, 1897, for additions to the plant, equipment of the road and betterments made thereon. From this statement it is learned that a total of almost seven millions of dollars have been spent for locomotives, passenger and freight equipment, extraordinary repairs to equipment and expenditures made by the Engineering Department in the way of improvements to the maintenance of way, structures, terminals and the construction of new aliguments and miscellaneous improvements. Of this great sum nearly five millions have been expended on rolling stock and about two millions on permanent way. These figures do not include the order for 58,000 tons of 85-pound steel rails recently ordered and which will cost in the neighborhood of one million.

The experience of those using mechanical stokers appears to furnish another instance of wherein the "doctors disagree." According to Power, the Steam Users' Association has been seeking information on the subject. To the question "Do stokers save coal over hand firing?" one reply showed a loss in economy, five reported no saving, and six reported a saving. The balance could not tell. One plant reported a large saving due to using a cheaper grade of coal than could be fired by hand. In reply to the question "Do stokers save labor over hand firing?" one found increased cost in labor, three found no saving, and eight found a saving. Three of the first four thought they could arrange to make a saving if their plants were fully equipped. In reply to the question "Do stokers save smoke over hand firing?" two soft coal plants thought they did not, seven thought they did. As to repairs, only five had had stokers in use over two years and of these three replied that repairs were small or trifling; the other two did not reply to the question on repairs. Five thought they responded slower than hand firing to a call for steam; one equally as quick and five quicker; three thought they needed more draft; four the same, and one less draft than a hand-fired furnace; five did not intend to increase their use of stokers or had already discarded them, three were doubtful, while six intended to increase. No plant was able or willing to say whether there had been any net gain from their use of the stoker.

In a paper read before the American Society of Heating and Ventilating Engineers, by Prof. J. H. Kinealy, on the determination of the volume of air passing through a register, the author states that in determining the volume of air flowing through a register per minute it is customary to determine the velocity in feet per minute at the surface of the register by means of an anemometer and then multiply this velocity by either the area of the face of the register or some fractional part of this area. This involves two separate and distinct problems, as follows: 1. The determination of the velocity of the air by the anemometer. 2. The determination of the fractional part of the area of the face of the register by which the velocity should be multiplied. The author then describes the several methods in which the anemometer is ordinarily employed for this work and proceeds to describe some tests made by himself on a register 13¾ by 21¼ inches in area, the opening through which aggregated 60 per cent. of the total area of the face of the register. Readings were taken with the anemometer placed ¼ inch above the register and moved to various positions over its area; also readings were taken on top of an airtight box 2 ft. high placed on the register and having the same area as the register. As a result of these tests the author finds that the fractional part of the area of the face of the register by which the velocity should be multiplied to get the total delivery of air from the register is about .80 for the particular case in point, and from later tests on other registers he is inclined to think that a good rule for all cases is to take one-half of one plus the ratio of area of openings to total area of register as the effective area. This will generally bring the factor between .80 and .85.

Of all of the lightships along our coast probably the South Shoals lightship, off Nantucket, has the most dangerous and at the same time the most important post. She has been torn from her moorings many times. That a chain and anchor could be made strong enough to hold any vessel against the winds and seas is probable, but the trouble heretofore has been that the great weight of such a chain tends to drag a vessel's head under the seas, and, although the chain might hold, the vessel either would be swamped or the unyielding nature of the chain would cause the vessel to tear away at the fastenings on her. To obviate this difficulty the Lighthouse Board has devised a new mooring, which is to be tried for the South Shoal lightship. The mooring chain is to be 200 fathoms long and of iron 1¾ inches in diameter. Instead, however, of having this great chain pass directly from the anchor to the ship, and so bear her down with its weight, it will past first a big mooring buoy. This buoy will bear up the weight of the chain, and in addition will contain a heavy coiled steel spring, which will give and take with the strains which the seas put upon the vessel, and make the whole cable elastic. Where the cable is made fast to the ship there will be another spring rider which will have six feet play, adding to the elastic nature of the mooring. The vessel will be provided, moreover, with a 100-fathom hawser, 12 inches in circumference, which her crew will bend on and over the end of the mooring cable in very bad weather. It will take a pull of 85,000 pounds to break this hawser. Riding at the end of the 300-fathom lines, away from the mooring anchor, and with the elasticity of the hempen hawser added to the spring arrangements already mentioned, it is believed a lightship will be able to weather all sorts of storms without damage to herself and without breaking away from her moorings.—New York Sun.

Personals.

Mr. Murat Masterson has been elected Vice-President of the Raleigh & Western Railway.

Mr. M. H. Dooly was on March 4 appointed Receiver of the Gainesville, Jefferson & Southern.

Gen. J. G. Mann is President of the Tennessee Midland Railway Company, vice J. C. Clark, resigned.

Gen. George J. Magee, President of the Fall Brook Railroad, died at Nice, France, on March 11.

Mr. Thomas R. Brown, one of the Receivers of the old Seattle, Lake Shore & Eastern, died on Feb. 2.

Mr. J. K. P. Hall has been elected Vice-President and Secretary of the Buffalo, St. Mary's & Southwestern.

Mr. S. A. Sheppard, Master Mechanic of the Carrabelle, Tallahassee & Georgia, died at Lanark, Fla., March 14.

Mr. D. Hickey has been appointed Division Master Mechanic of the Union Pacific road, with headquarters at Evanston, Wyo.

Mr. H. D. Buaghardt has been appointed Purchasing Agent of the Minnesota & Wisconsin Railway, with office at Spring Valley, Wis.

Mr. C. B. McVay has been appointed Purchasing Agent of the Toleda, St. Louis & Kansas City, with headquarters at Toledo, O.

Mr. C. A. Gould, President of the Gould Coupler Company, sailed on the *St. Paul*, March 24, for a trip of several months in Europe.

Robert Patterson has been appointed Master Mechanic of the Florence & Cripple Creek Railroad with headquarters at Florence, Col.

Mr. G. A. Croft has been chosen Vice-President and Contracting Agent of the Wadley & Mount Vernon, with headquarters at Atlanta, Ga.

Mr. Nicholas Monsarrat, Vice-President of the Columbus, Hocking Valley & Toledo, was on Feb. 25 appointed Receiver of that road.

Mr. John Gill has been appointed Master Mechanic of the Illinois Division of the Chicago, Rock Island & Pacific, with headquarters at Chicago.

Mr. W. G. Taber, Master Mechanic of the Dunkirk, Allegheny Valley & Pittsburgh, died suddenly at Dunkirk, N. Y., Feb. 18, of heart disease.

Mr. B. F. Porter, Roadmaster of the Maricopa & Phœnix and Salt River Valley, will also have charge of shops and car repairs, vice T. J. Morrison, resigned.

Mr. Darius Miller has been appointed Vice-President of the Missouri, Kansas & Texas Railroad Company, in general charge of the traffic departments.

Mr. E. B. Thompson, for some time past Mechanical Engineer on the Chicago & Northwestern, has gone to the Northern Pacific in the same capacity.

Mr. F. H. McGee has been appointed Master Mechanic of the Georgia & Alabama, with headquarters at Americus, Ga., vice Mr. J. E. Worswick, resigned.

Mr. C. O. Johnson, who has had charge of all departments of the Pacific Coast Railway at San Luis Obispo, Cal., with the title of Superintendent, has resigned.

Mr. Russell Harding has been appointed General Superintendent of the Great Northern, with headquarters at St. Paul, in place of Mr. J. M. Barr, resigned.

Mr. William Grierson has resigned the position of Master Car Builder of the Dominion Atlantic Railway at Kentville, N. S., and has retired from railroad service.

Mr. Joseph Spragge has been appointed Master Mechanic on the Atlantic Division of the Canadian Pacific Railway, with headquarters at McAdam Junction, N. B.

Mr. W. A. Mills, General Manager of the Columbus, Hocking Valley & Toleda, has been appointed Traffic Manager of that road, and the office of General Manager is abolished.

Mr. James M. Barr has resigned as General Superintendent of the Great Northern and accepted the position of Vice-President of the Norfolk & Western, with headquarters at Roanoke, Va.

Mr. E. B. Gilbert, formerly on the Pittsburgh, Shenango & Lake Erie, has been appointed Master Mechanic of the new Pittsburgh, Bessemer & Lake Erie Railroad, with office at Greenville, Pa.

Mr. W. T. Gorrell, Assistant Master Car Builder of the Philadelphia & Reading, has been appointed Master Car Builder of that road, with headquarters at Reading, Pa., to succeed Mr. J. H. Rankin, promoted.

Mr. J. U. Jackson, President and General Manager of the Augusta Southern, has been appointed Assistant to the General Manager of the South Carolina & Georgia, which road has leased the Augusta Southern.

Mr. F. M. Leader has resigned as Ceneral Manager of the Bloomsburg & Sullivan, and the office is abolished. Mr. D. W. Campbell has been appointed General Superintendent, with headquarters at Bloomsburg, Pa.

Mr. William Sinnott, who has been Division Master Mechanic of the Baltimore & Ohio Railroad Company at Cumberland, has been transferred to Philadelphia. Mr. Courtney, of Grafton, W. Va., succeeds Mr. Sinnott at Cumberland.

Mr. W. G. Nevin, at present General Purchasing Agent of the Atchison, Topeka & Santa Fe, will, it is understood, succeed the late K. H. Wade as General Manager of the Southern California Railway, with headquarters at Los Angeles, Cal.

Mr. James D. Livingston has resigned as Vice-President and General Manager of the Lexington & Eastern, and Mr. A. W. Barr has been appointed General Manager and Mr. George Copland Vice-President, with headquarters at Lexington, Ky.

At a meeting of the Trustees of the Schenectady Locomotive Works, held March 6, Mr. William D. Ellis was elected President, in place of Edward Ellis, deceased; Mr. Albert J. Pitkin, Vice-President and General Manager; and Mr. A. M. White, Superintendent.

Mr. S. F. Parrott, recently General Manager of the Columbus Southern, has been chosen Vice-President and General Manager of the Gulf City Construction Company, which concern is building the Mobile, Jackson & Kansas City road. Headquarters, Mobile, Ala.

Mr. C. M. Higginson, who about a year ago was made Assistant to the President of the Atchison, Topeka & Santa Fe, has accepted the position of Purchasing Agent for the system, left vacant by the appointment of Mr. W. G. Nevin as General Manager of the California lines of the company.

The offices of General Superintendent, Chief Engineer, Superintendent of Motive Power, General Road Master, and Superintendent of Bridges and Buildings of the Alabama Great Southern Railroad have been abolished, and the control of the departments placed in the hands of Superintendent Wickersham, who will, as heretofore, report to Mr. Vaughan, Assistant General Superintendent, at Chattanooga.

Mr. Kirtland H. Wade, General Manager of the Southern California Railway, died suddenly at Los Angeles, Cal., March 11. Mr. Wade entered railway work at the age of 14 years as a telegraph operator, and advanced until, in 1870, he was Master of Trains of the Illinois Division of the Wabash. Later he became Superintendent of the Ohio & Indiana Division. In 1881 he went to the C., B. & Q. R. R., but returned to the Wabash in 1882 as Superintendent of Transportation. In November, 1889, he accepted the general management of the Southern California.

Mr. Edward Ellis, President of the Schenectady Locomotive Works, died at his home in Schenectady on the night of Feb. 27, at the age of 53 years. The company of which he was President was organized in 1848 as the Schenectady Locomotive Engine Company. In 1850 the works were purchased by John Ellis, D. D. Campbell and Simon Groot. The following year the Schenectady Locomotive Works were incorporated, and by 1863 Mr. John Ellis had acquired nearly all the stock. He was President until his death, Oct. 4, 1864, and since then the position has been held successively by three of his sons, Mr. Edward Ellis becoming President in 1891.

Mr. Thomas Seabrook, who was for years prominent in the engineering department of the Pennsylvania Railroad, died in Philadelphia on Feb. 24, in his 80th year. His first service in the employment of the company was as an engineer in locating the line through the western part of Pennsylvania. Later he was stationed at Gallitzin, in charge of construction work. In 1854 he was appointed Assistant Superintendent of the Western Division and in 1857 was appointed Resident Engineer in charge of the road between Harrisburg and Pittsburgh. In 1859 he became Chief Engineer of the Western Transportation Company, in charge of the survey and construction of lines west of Pittsburgh, now a part of the Panhandle route. His last important railroad work was the building of the eastern end of the West Shore Railroad.

The passenger department of the Mobile & Ohio Railroad recently sent out something unique in the way of railway advertising flyers or bills. It is a deep-blue banner or hanger about three inches wide and 20 inches long, and in red and white letters conveys the information that three premiums for fruits, grains and grasses, given at expositions, are positive proof of the richness of the lands along the line of the M. & O. R. R. A list follows of the cheap excursions which the road will give to the lands still for sale, which aggregate 500,000 acres. The novelty of these bills has caused such a demand for them that 350,000 have been sent ont, and General Passenger Agent Mr. E. E. Posey says the inquiries for them are more numerous than ever.

The Friction of Piston Valves.

At the 1896 convention of the Master Mechanics' Association, a committee reported on slide valves and gave the results of elaborate tests on the friction of slide valves, balanced and unbalanced. The Chicago, Burlington & Quincy Railroad has since that time applied the same apparatus to the piston valves of its engine No. 498, with the result given in the accompanying table. The methods employed were the same as those used by the committee, and the results are comparable to some extent. In looking up the figures given in the report alluded to we find that most of them were conducted with a very low steam chest pressure and this is one of the barriers to a comparison of results. Probably no two persons would make the same selections from the mass of figures on plain and balanced slide valves given in the report for comparison with the figures here given, but in order to give our readers an idea of the relative frictions we have ventured to compile table No. 2. It will be seen that the figures are somewhat erratic, but in general the percentage of power consumed by the piston valve is much less than that of the balanced valves. In the third group of the table, including lines 9 to 15, the higher speeds and pressures for the piston valve tests need to be borne in mind. Making allowance for these differences the average indicated horse-power of the valve cards is even then somewhat greater than in the single trial of a balanced valve with which it is compared, though on the basis of the percentage of power absorbed the showing is in favor of the piston valve.

TABLE NO. 1.—SHOWING FRICTION OF PISTON VALVES IN ENGINE 498, C., B. & Q. R. R., TESTED JULY 31, 1896.

Rev.	Steam chest pres.	Cylinder card.			Valve card.						S. C. press. by 4.81.†	I. H. P. valve cards.	Per cent. of I. H. P. of cyl.
					Length	M. E. P.							
		Cut-off	Ave. M.E.P.	I. H.P.		Front.	Back.	Ave.	Diff.	Diff. by 7.07.*			
75	100	18 in.	81.4	210	3.14	85.8	28	56.9	57.8	409	481	.48	.24
81	145	14 "	108.6	303	2.46	117.6	7.8	59.2	102.8	717	697	.42	.14
109	130	14 "	93.1	353	2.34	117.9	5.1	61.5	112.8	798	625	.56	.16
109	140	9 "	65.6	246	2.03	98.9	16.1	57.5	82.8	575	673	.45	.18
163	145	7 "	40.8	230	2.02	139.4	38.8	89.1	100.6	721	697	1.05	.46
190	145	7 "	37	243	2.04	157.2	45.4	106.2	111.8	790	697	1.4	.60
65	80	18 "	71 3	159	2 97	78.8	28.8	53.8	50	353	385	.37	.22
109	90	18 "	70-5	264	3.10	25	12.7	18.9	12.3	90	433	.33	.08
163	117	14 "	64.8	363	2.72	168.2	16.4	62.4	91.8	649	562	.99	.28
54	145	14 "	117.6	279	2.42	84.9	14.2	49.6	70.7	500	697	.23	.11
163	150	9 "	47 1	264	2.16	131	12.1	71.6	118.9	840	722	.9	.34
Averages.....				260						576	606	.64	.25

* 7.07 = Area of dynamometer piston.
† 4.81 = 2 by area of valve stem.

We give the figures in Table No. 2 as the fairest comparison that we can make with individual tests. Taking these tests and the M. M. committee tests in their entirety we find the average power consumed by the piston valve to be .25 per cent. of the cylinder power, while the best balanced valves in the M. M. committee tests averaged .61 per cent., showing the piston valves to consume about one-half as much power as the latter.

It is interesting in this connection to note that the difficulties encountered in times past by those who tried to use piston valves appear to be overcome. The most serious of these troubles arose from the earlier piston valves being altogether too small for the work. At present the tendency to use piston valves for simple locomotives using high steam pressures is quite marked and we should not be surprised to see them quite generally introduced in the near future.

TABLE NO. 2.—COMPARISON OF UNBALANCED AND BALANCED SLIDE VALVES WITH PISTON VALVES.

Line.	Kind of valve.	Speed. (Rev.)	Steam chest pres. lbs.	I. H. P. of valve cards.	Per cent. of cyl. power consumed by valve.
1	Unbalanced slide.....	212	130	3 19	1.62
2	Balanced slide.....	212	129	1.38	0.62
3	Piston.....	190	145	1 40	0.60
4	Unbalanced slide.....	106	106	1.28	.....
5	Balanced slide	106	103	0.53	0.45
6	Piston	109	135	0.50	0.17
7	"	109	90	0.33	0.08
8	" (average of 6 and 7).....	108	113	0.42	0.13
9	Unbalanced slide.....	53	93	0.58	0.12
10	Balanced slide.....	53	90	0.19	0.37
11	Piston	65	80	0.37	0.22
12	"	54	145	0.23	0.11
13	"	75	100	0.48	0.24
14	"	81	145	0.42	0.14
15	" (average lines 11, 12, 13, 14)	69	117	0.37	0.18

A Seven-Foot Boring and Turning Mill with a Slotting Attachment.

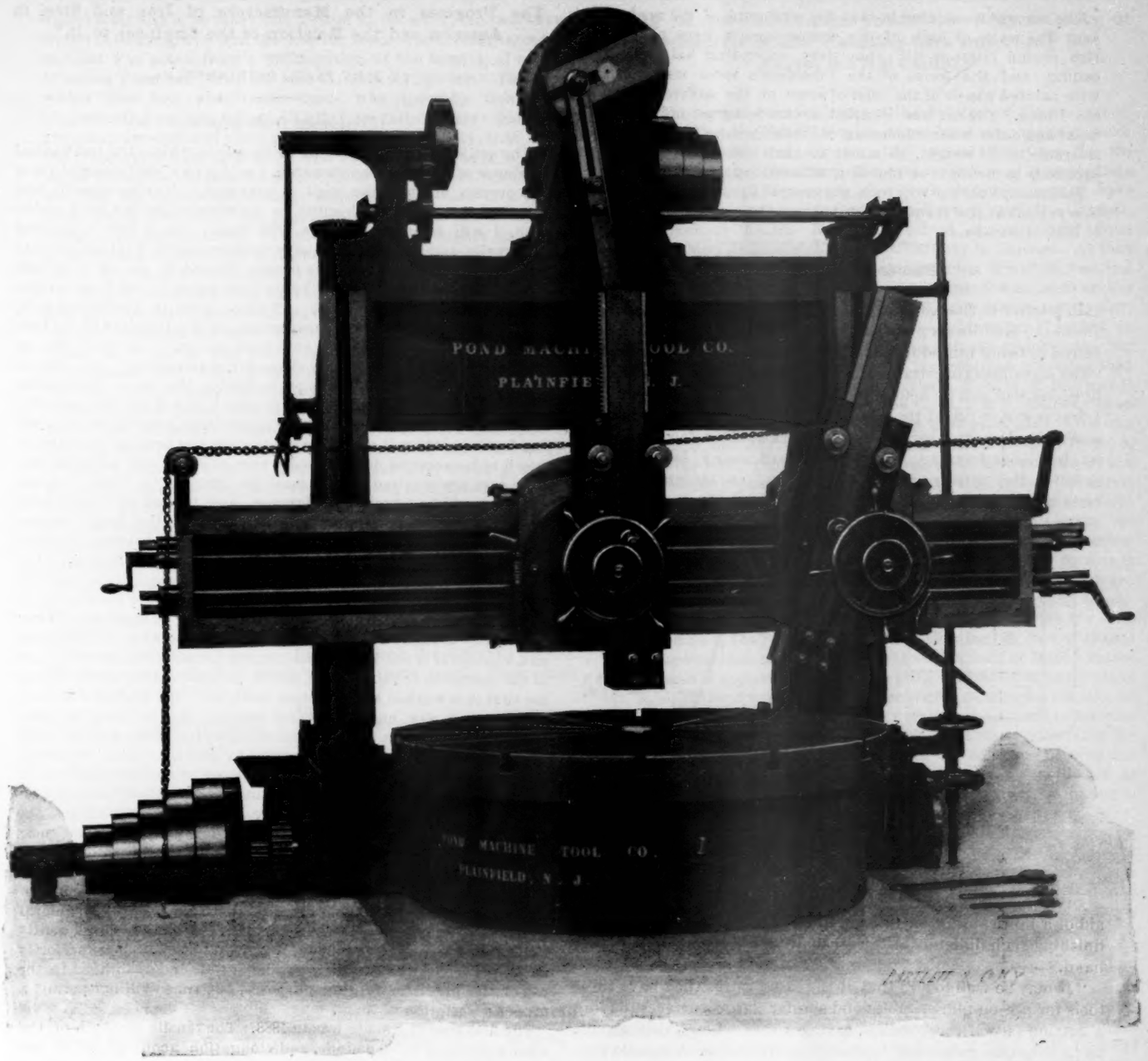
We illustrate herewith an excellent and powerful tool built by the Pond Machine Tool Company, Plainfield, N. J. It is a seven-foot boring and turning mill, to which is fitted a slotting attachment, thus giving the tool a wide range of utility.

The mill will take in work 85 inches in diameter and 48 inches high. The face plate is 78 inches in diameter and has a very wide bearing on the bed, nearly equal to the diameter of the plate, and is mounted on a spindle having large bearings adjustable for wear, and with sufficient length to avoid any possibility of the face plate tipping when the tools are taking heavy cuts in their highest position. The lower bearing of the spindle is mounted on a step resting on a wedge which can be adjusted so as to lift the plate off its bearing on the bed when it is required to revolve at high speed or moved by hand when setting and fastening work. This wedge is adjusted from above the floor, thus making it convenient for the operator. The table has 10 changes of speed, and is driven by a cone of large diameter with wide steps for the belt, and geared to an internal gear.

The tool-slides, saddles and crossrail are all made very strong, and are provided with large bearing surfaces. The tool-slides have a traverse of 48 inches and are counterbalanced. Their large flat wearing surfaces fit the entire length of the swivels, making the strongest possible support. The tool holders are of the favorite form, consisting of two straps and four bolts, permitting the use of ordinary lathe or planer tools. The swivels are set at any desired angle by means of a worm and ratchet mechanism. The crossrail has large wearing surfaces and is elevated by power. The saddles are attached to steel feed-screws by nuts, which can be quickly opened, and a rapid movement of the saddles obtained by means of a ratchet and a pinion engaging a steel rack on the crossrail. The feeds of the two tools are independent of each other and can be instantly changed from zero to the maximum. The feeds are operated by a friction wheel, the parts being so proportioned as to give ample power under all conditions.

When so desired this tool can be used for turning pulleys on an arbor, and for this work there can be furnished an equalizing drive-plate, a saddle on the crossrail fitted with a spindle similar to the tail spindle of a lathe, and a center fitted to the face-plate.

The slotting arrangement is carried on a pedestal mounted on the top of the arch and fastened to it by means of bolts in T slots, permitting it to be placed in line with the tool-slide when the latter is located over the work. It consists of a worm-driven crank disk slotted for a pin adjustable from 6½ inches to 18 inches stroke. It will be noticed from our engraving that the connection to the tool-slide is slotted; this is for the purpose of adjusting the stroke to the location of the slot to be cut. The slotting attachment has three speeds. The cone on the countershaft can be adjusted to any position along the shaft to suit the location of



Seven-Foot Boring and Turning Mill With Slotting Attachment.—Pond Machine Tool Company.

the cone on the pedestal when the slotting arrangement is in position for work.

Excellent workmanship and substantial design, combined with the greatest possible convenience to the operator, serve to make this tool all that can be desired, and its special features give it a wider range of usefulness than is ordinarily attained. It is placed on the market by the well-known firm of Manning, Maxwell & Moore, 111 and 113 Liberty street, New York City.

Lincoln's Car.

In an obscure corner of the yards of the Union Pacific car shops in Omaha, in a delapitated and abandoned condition stands a truly historic relic known as the "Lincoln car." Its sides are cracked and weather-beaten, and the glass in its windows and the brass railings on its platforms are long ago gone. All the compartments and sumptuous interior furnishings and decorations have been removed, and it stands like a barren, decaying hulk of its once proud self. From its former prominent association with President Lincoln, both during the later years of his life and then after his death, it would seem the car deserves a better fate than to rot in neglect and obscurity. This car was built especially for Mr. Lincoln in the United States military car shops at Alexandria, Va., in 1864, by B. P. Lamason, Master Car Builder, and was certainly one of the handsomest private railway coaches in its day. It was used by the President repeatedly in his visits to the army of the Potomac down in Virginia, and also to New York and Philadelphia.

The Lincoln car is 42 feet long by 8½ feet wide, and during the time Mr. Lincoln used it was divided into three compartments. It was entered by a door which opened into a narrow passageway extending the entire length of the car along one side.

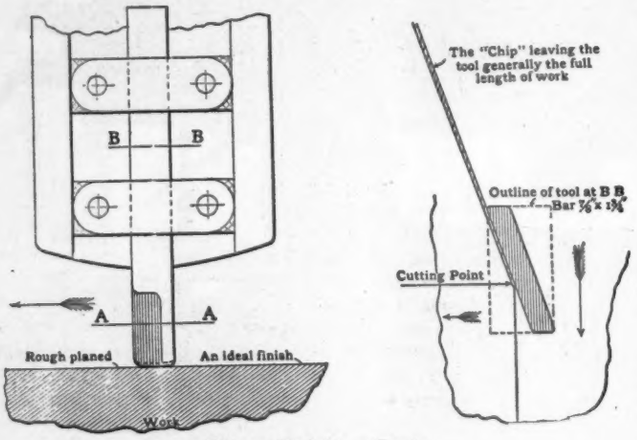
From this passageway doors opened into each one of the three private rooms. The room in one end of the car was considerably larger than the others, and was furnished with a large sofa and reclining chairs, although somewhat inferior to those in the large room. This larger compartment constituted President Lincoln's office and study, and was where he entertained his guests and transacted business with officials of the government and generals of the army. The sofa is a combination affair and was made of unusual length to accommodate the elongated form of the President: It was used as a sofa or lounge during the day and at night could be adjusted into a double bed.

The car was considered in that day a triumph of the car builder's art. The walls of each of the compartments were padded with rich corded crimson silk upholstery, extending half way to the ceiling, and the freize of the President's room was decorated with painted panels of the coat of arms of the different States of the Union. The car was ironclad, armor being set in between the inner and outer walls, rendering it bullet proof. This added considerable to its weight, so much so that its buildets thought it necessary to mount it on four four-wheeled trucks.

This famous old car will form the central figure of the transportation exhibit at the Trans-Mississippi and International Exposition of 1898, at Omaha.

Planer Finishing Tools.

In a letter to the American Machinist Mr. Wm. Pilton, of Hamilton, O., describes a planer finishing tool as follows, the cut referred to being reproduced from the pages of our contemporary: "The accompanying drawing will make clear to the reader this finishing tool and its helical rolled chip of steel or wrought iron. I first saw it in use at the Niles Tool Works, and learned that it was arrived at after several experiments made, a few years ago by the planer foreman, who has received many inquiries for a sketch. Its cutting action is perfect, as shown by chips from heavy and light finishing cuts. It works well without the



Planer Finishing Tools.

aid of a lubricator or cutting solution, solving the problem of finishing such difficult metals—usually very trying to a planer hand.

"It may be well to add that at the same works they have these tools for use on planer tables and similar large surfaces, having a cutting face of three inches, giving a very wide finishing cut, and a chip that rolls itself 'spirally' several turns. A sample generally finds its way to the tool chest as a curiosity and to give support to the story. Those who have been accustomed to fine machine feed finish have looked with surprise on the ¼ to a 2 crank-turn finish feed.

"Wide-face Mushet steel tools are used in reducing to size between the one roughing and the final finishing cut; and for this last a tool is used which has received almost the care of a razor in its preparation for the work."

Association Scholarships.

The Secretary of the Master Mechanics' Association announces that there will be two vacancies in the association scholarships at the Stevens Institute of Technology, at the close of the present college year in June. Sons of members of the association who are eligible for these scholarships, and who desire to attend the preliminary examinations, should apply to the Secretary, and, if found eligible, he will give a certificate to that effect for presentation to the school authorities, which will entitle the candidate to attend the preliminary examinations. These examinations will begin at the Institute on June 4 and continue until June 10. When it is desired, the school authorities will arrange for the examination of an applicant at any of the large cities of the country, but in that case the applicant must pay the Institute a fee of $10, to cover the additional cost of conducting the examination there.

The Progress in the Manufacture of Iron and Steel in America and the Relation of the Engineer to It.*

BY JOHN FRITZ, BETHLEHEM, PA.

(*Continued from page 62.*)

The subject of hollow forging being one in which the mechanical engineer is more or less interested, I will give a brief description of the process, and how the ingot is prepared. Having already told you that the metal is subjected to pressure while in a fluid condition, I will commence with a cold ingot. It is first examined externally, and if there are no imperfections visible it is then put into a powerful lathe, and after the proper discard is cut off it is then cut to the proper length, that being determined by the final weight of the forging it is intended for. Next it goes to the boring mill, and is bored out to a size corresponding to the diameter of the hole in the finished forging. You now have the ingot (or such part as you want) in the best possible shape for examination; and this is not all, for the center of the ingot is always the most undesirable part of it, and the boring of the hole gets it out of the way entirely. We now have it in the most desirable condition possible for the heating furnace, where it next goes, and it is in the heating that it is exposed to its greatest danger, and where skill and the greatest possible care are required, and it must be charged in a cold furnace, which should be a preheating furnace, and heated up slowly until the heat reaches the center; it is then taken to the forge furnace, and heated slowly and regularly (in order to prevent internal strains), until it reaches the proper temperature for forging. The higher the carbon the more care is required, especially in the first heating, it being the crucial test and the time when the damage is generally done; if once done, it cannot possibly be repaired. When it is finally brought up to the proper heat it is taken to the press, and a mandrel is put in, and the forging commenced, and this part of the operation requires skill, sound judgment and great care to see that it is worked at the proper heat, and in a manner that will not produce any undue internal strains, and in irregular forgings special car must be taken in shouldering down and in working up flanges or projections, in order to prevent "fins," or excrescences, from forming, that may unnoticed work into the body of the forging. One of the great advantages of hollow forgings over solid is that by boring out the center of the ingot the metal is reduced to less than one-half the thickness of the solid forging, and by using the press, the action being slow, the ends of the forging are convex, showing that the force of the press had reached the center of the metal, while the hammer strikes a quick and sharp blow, affecting the outside of the metal to a much greater extent than the inside or center, consequently the end of the forging is concaved, showing at once the superiority of the press over the hammer. There are other advantages in the use of the press for forging purposes, but time will not permit a proper description of them.

The first shafting made was in 1888. The tensile strength of the steel was about 60,000 pounds, and elongation about 28 or 30 per cent. in two inches. At that time but little attention was given to the elastic limit or the contraction of area, which is now considered important, especially the latter.

Test bars taken from a certain puddled bar reworked car axle varied between 44,000 and 45,000 pounds, the elastic limit between 18,000 and 23,000 pounds, the elongation between 21 and 27 per cent., the contraction of area between 40 and 48 per cent.; compare this with some results obtained in hollow-forged, oil-hardening, and annealed nickel-steel shafting, the physical properties of which are: tensile strength, 95,000 to 100,000 pounds; elastic limit, 60,000 to 65,000 pounds; elongation, 20 to 25 per cent.; contraction of area, 55 to 60 per cent. It is safe to assume that in shafts of any size a nickel-steel shaft as above would have three times the elastic strength of a wrought-iron shaft, and taking into consideration the fact of hollow forging with judicious proportioning of inside and outside diameter, it would be possible to make a nickel-steel shaft of one-quarter the weight of a wrought-iron shaft and obtain the same elastic or working strength. The greater contraction of area shown by the nickel steel proves it a safer material against shock, as the greater the contraction the greater will be the amount of local distortion that can take place without rupture. This is clearly shown by the old but still reliable bending test, which is always in proportion to the contraction of area, and not to the elongation, as most commonly supposed. This

* From the President's address before the Amer. Soc. of Mech. Engineers.

nickel-steel test is no fancy one gotton up for show, but was taken from the forging, and was the test the work was actually accepted on, and was taken from a prolongation of the forging of a shaft 17 inches diameter, with the hole 11 inches diameter. The shaft which this test was taken from was specially treated by oil-hardening and annealing. While I am fully aware that there are many persons, and some of them high in authority, that doubt the propriety of such treatment, yet when the work is in a proper shape to receive the treatment, and it is made with intelligence and care, my experience has fully convinced me that this special treatment produces the best possible results, and for many purposes it is indispensable. Steel can be made higher in tensile strength and elastic limit than the test referred to, but to some extent it will be at the expense of extension and contraction of area.

I have already said that it was not the object of this paper to give any definite instructions as to the kind of steel to be used for various purposes, yet a few remarks showing how very difficult it would be to do so may prove both interesting and instructive. Forgings are made from grades varying from .10 carbon to 1.00, according to the purpose for which they are to be used.

The physical properties, as shown by test bars, will vary with the carbon, the size of forging, the amount of work put upon it; that is, two similar forgings made from different sized ingots will give different results. The treatment after forging, such as annealing, oil-hardening, etc., where varying temperatures produce widely varying results, with all these conditions to be considered, it is quite impossible to give definite figures unless the conditions are well known. Take for instance two forgings of considerable difference in size and shape, both of which must show about the following properties:

Tensile.	Elastic limit.	Elongation.	Contraction of area.
80,000	45,000	15	50%

One may require a steel of .30 carbon and the other .45 carbon. These two steels, if rolled down to small bars, would show about the following results:

Carbon.	Tensile strength.	Elastic limit.	Elongation.	Contraction of area.
30	85,000	50,000	22	55 per cent.
45	95,000	60,000	18	50 "

Under ordinary conditions the elastic limit is about 50 per cent. of the tensile strength. In order to increase this proportion special treatment of the forging is resorted to. The elongation and contraction of area are also increased by treatment, especially the latter, so that with the elastic limit and contraction we have a safe index as to the condition of the metal, and as these two properties vary much less with the length and diameter of test bar, they are more valuable in comparing results from varying sizes of test bar. As the carbon in steal increases, the variation, due to work reduction, becomes less, while that of annealing becomes greater. The variation obtained by treatment increases rapidly with increasing car bon.

Steel .45 in carbon showing:

Tensile Strength.	Elastic Limit.	Elongation.	Contraction of Area.
90,000	45,000	15	40%
By oil-tempering:			
96,000	55,000	18	50%

The above are about the best figures to be used in forging ordinary work. If higher or lower strength is required, it may be obtained by varying the carbon. If increased strength and elastic limit are required, without sacrificing toughness, it may be obtained by using nickel steel.

In conclusion, the modern practice of steel making has, in the hands of the mechanical engineer, the metallurgist, and chemist, wrought wonders in producing a material which in quantity, physical qualities, and cheapness would have been regarded as utterly impossible half a century ago, when steel rails, beams, angles and plates were not thought of. The labors of the men of iron and steel have so cheapened their products that to-day we are enabled to use steel for the commonest purposes as well as for the most expensive articles produced by the skill of the mechanic. No article is too humble to be made of it, and no structure so grand and important as to refuse its services; it is demanded in the frying-pan as well as in the vast bridges and viaducts, as well in the housewife's needle as in the great leviathans that have made the ocean but a span of less than a week; thus we find steel asserting its value through every walk of life, and extending to every clime, linking lands in that bond which grows broader and stronger with the years, till even now we can see, if but dimly, on the horizon the promise of the linking of nations in the universal brotherhood of mankind, and bringing the longed-for era of eternal peace.

Ruling of the Arbitration Committee—Responsibility of Intermediate Roads Handling Cars Improperly Repaired, but Not Carded.

From the report of the decisions of the Arbitration Committee of the Master Car Builders' Association rendered at meetings held in December, 1896, and January, 1897, we publish Case No. 394 which is important as fixing the responsibility of intermediate roads handling foreign cars on which improper repairs have been made, but not carded for. On Sept. 3, 1896, the Chicago, Rock Island & Pacific Railway received its car 31,056 from the Lake Shore & Michigan Southern Railway in Chicago. At that time the C., R. I. & P. inspector noted a wrong drawbar, two lug castings and wrong draft timbers. A demand was made on the L. S. & M. S. inspector, and L. S. & M. S. card was issued on Oct. 6, calling for "one wrong malleable pocket drawbar 27 inches in place of 24 inches long," and the inspector refused to give card for the wrong draft timbers and wrong lug castings, claiming that while the car was in the possession of the L. S. & M. S. Railway it made no repairs to these items. The C., R. I. & P. Railway then took the matter up on these facts, by correspondence with the L. S. & M. S. Railway, and the latter argues that the new Rules of Interchange clearly indicate in the preamble that car owners are responsible for repairs of damage other than that caused by unfair usage, and that where cars are damaged by unfair usage the company damaging the car must make proper repairs or card the car covering such damage; it calls attention to the fact that Section 49 of Rule 3 states that a company making improper repairs is solely responsible to the owners, with certain exceptions which are named; also, that Section 15, Rule 4, says that a company repairing cars with wrong material and not in compliance with the Sections of Rule 4, shall be liable to the owners for the cost of changing to the requirements of the rule; that Section 5 of Rule 5 states that when the repairs have not been properly made the owners may bill against the company making the wrong repairs for the cost of changing the car to the requirements of Rule 4. It claims that the rules thus clearly indicate that the settlement of responsibility for wrong repairs is between the owners and the company making the wrong repairs, and it does not find any reference, either direct or indirect, in the rules to the effect that an intermediate company is responsible for the wrong repairs made by another company.

The C., R. I. & P. Railway Company claims that the L. S. & M. S. Railway Company admitted responsibity by issuing card for the wrong drawbar, as it is fair to assume that the wrong drawbar was applied at the same time the two wrong-framed draft timbers and the two foreign lug castings were applied; that these items break the combination and make it a case of rough handling; it quotes Rule 1 of the M. C. B. code, which says: "Each railway company shall give to foreign cars while on its line the same care as to oiling, packing and inspection that it gives to its own cars," and it argues from this that the L. S. & M. S. Railway Company has not complied with the rules, as if it had not damaged this car and made wrong repairs it should have protected the C., R. I. & P. Railway the same as it would have protected the L. S. & M. S. Railway in the case a of L. S. & M. S. Railway car being offered home with similar wrong repairs. It says that if this car was received on the L. S. & M. S. Railway and Section 49 of Rule 3 had not been complied with, it was the duty of the L. S. & M. S. Railway to protect itself and thereby protect the owner; that if the intermediate line handling the car last is not made responsible in some way there is nothing to prevent foreign lines, after having damaged a car, from sending it home and the owner being unable to place the responsibility.

To this the Lake Shore replies that it received the car from the Pennsylvania Railroad at Erie nine days prior to date of its delivery to the Rock Island and that no repairs were made to the car while in its possession. That its reason for issuing the defect card for wrong drawbar was to comply with Section 46 of Rule 3, which makes the delivering road responsible for improperly fitting drawbars, and that the owners claimed it was three inches too long.

Failing to settle the matter, it is referred to the Arbitration Committee, by mutual consent, for decision. The committee decided as follows:

This question involves the responsibility of an intermediate railroad for wrong repairs which it did not make. Under the rules which went into effect Sept. 1, 1896, Section 49 of Rule 3 states that the company making wrong repairs is solely responsible to the owners, with certain exceptions noted, but the rule also provides that the company making the repairs shall apply a repair card, and,

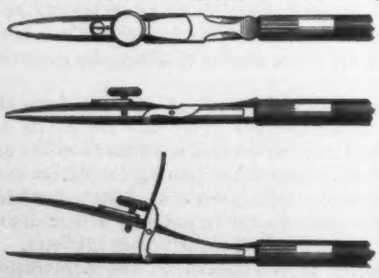
if improper repairs are made, accompany the repair card with a defect card. The second paragraph of the preface says: "Railroad companies handling cars are responsible for damage done to any car by unfair usage, derailment, accident, *or improper repairs*, and they should make proper repairs at their own expense, or *issue defect card* covering *all such damage*." The inference from Rule 1 and from the last paragraph of Section 1, Rule 3, is that a car-owner's interest is protected by intermediate lines giving such cars the same attention and inspection that they would their own cars. Where Section 49, Rule 3, says, "Solely responsible to the owners," it means that it is not responsible to anybody else for improper repairs *under the rules*, but the rules do not say that if a railroad company fails to comply *with the provisions of the rules* for locating responsibility, that the intermediate road may also escape responsibility by simply stating that it did not make the repairs. To escape responsibility it must see that either a repair card or a defect card is carried, or must itself furnish a defect card for the wrong repairs. Any other construction of the rules would be encouraging any kind of repairs to owner's cars and would be offering the strongest inducements to railroad companies to evade the use of repair cards as well as defect cards, which form an essential part of the rules and are expressly provided for in Rule 4, Section 16, and Rule 3, Section 1.

It is argued that a discussion was had at the last convention on this very point, and that a motion to amend the last paragraph of Section 1, Rule 3, by adding after the word "Responsible," the words, "Or improper repairs covered by a repair card," was voted down, and therefore it was evidently not the intention of the association to demand responsibility in the way of inspection by intermediate roads in such cases. This argument would stand in this case if the car had carried a repair card, covering repairs to these parts. The joint-evidence statement of the Rock Island and Lake Shore roads as to the condition of the repairs would have been sufficient to warrant collecting from the parties making the repairs, who would be located through their cards. The Arbitration Committee has an intimation from the discussion above referred to as to what the association thought when a car having wrong repairs carried a repair card, and no defect card, but it has no intimation of what course the association would think best if neither a repair card nor defect card is attached to the car, except by inference from the rules themselves. The Arbitration Committee cannot believe that the association contemplates ignoring the rights of car owners in the way that would inevitably follow should they rule that cars may be received by intermediate railroads with evident wrong repairs and without being accompanied by a repair card or a defect card and not incur any responsibility. Such a construction of the rules would quickly do away with the use of both repair cards and defect cards.

In the opinion of the committee, the Chicago, Rock Island & Pacific Railway Company was justified in demanding a card for the wrong repairs found on its car at the time of inspection.

The Alteneder Lever Ruling Pen.

Every draughtsman has experienced the annoyance and delay incident to the alteration of the line-adjustment of a ruling pen when it is being cleaned. The well-known firm of Theodore Alteneder & Sons, Philadelphia, makers of high-grade drawing instruments, have recently brought out an ingenious pen in which that difficulty is overcome. It is shown in the accompanying engraving. The pen is made in one piece, with the upper blade in the form of a spring, the action of which is such as to constantly press the points together. The adjusting-screw is fitted to the upper instead of the lower blade (as is usual), and merely bears against the inner surface of the latter, thus separating the points to obtain the desired width of line. A lever having parallel arms is pivoted to the lower blade, and is provided with a bar connecting the two arms and located between the blades. When the lever is lifted, the bar raises the upper blade and holds the points apart for cleaning. After the pen is cleaned the lever is pushed down and the points assume their former relation to each other, the adjusting screw having remained untouched. Not only is the adjustment undisturbed, but the cleaning is easily and rapidly done. A five or five and one-half inch lever pen with ebony handle is listed at $2.50. They are also furnished with aluminum or ivory handles if desired. The address of the makers is 945 Ridge Avenue, Philadelphia, Pa.



Apparatus for the Combustion of Powdered Coal.

Some time ago we illustrated an apparatus for burning coal in which the blast performed several functions besides that of actually carrying the powdered fuel to the firebox. Herewith we reproduce from our contemporary Engineering the engravings of the Ruhl apparatus, the distinctive feature of which is that the conveying and the feeding mechanism are combined, avoiding the need of any further apparatus. Further, by providing for two worm conveyors acting in opposite directions, the storage chamber has been dispensed with. The draft has to carry the dust through a short distance only.

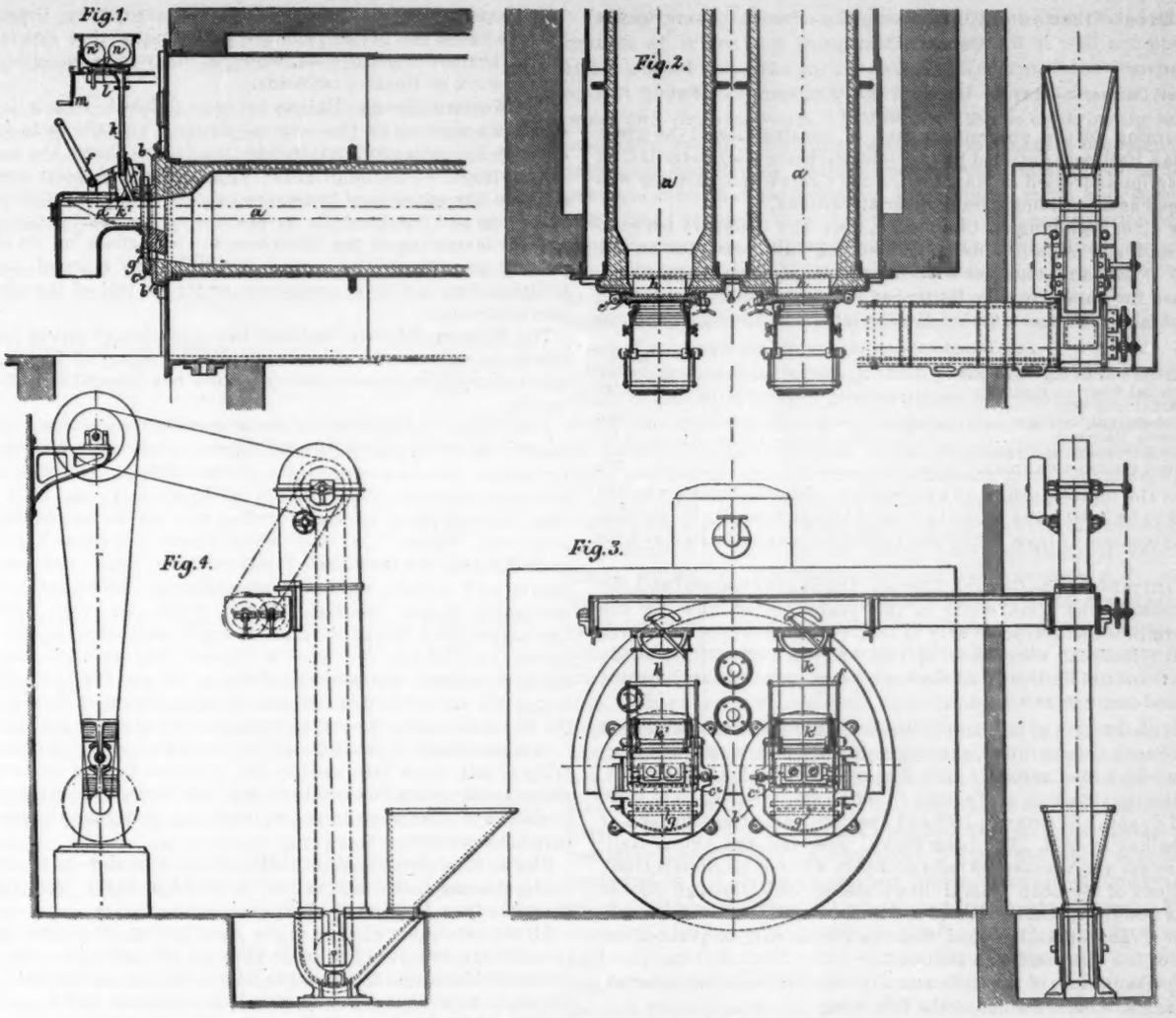
"The boiler which was fitted with this apparatus had a length of 8 meters (26 feet 3 inches), a diameter of 2 meters (6 feet 6 inches), and a heating surface of 58.8 square meters (633 square feet). It actuated two pulsometers supplying 6,000 and 7,000 liters (1,320 and 1,540 gallons) of water per minute for the fountains and cascades. The iron chimney, close to the boiler-house, had a height of 20 meters (65 feet), and a diameter of 0.6 meter (2 feet).

The two furnaces, 700 millimeters (27.6 inches) in diameter, were lined with firebrick over a length of 3 meters (10 feet). This space forms the furnace chamber a (see Figs. 1 and 2 annexed); there is no grate. The chamber is closed in front by a cast-iron frame b lined with firebrick on the inside, and the door c. This door supports by means of levers f (Fig. 3) an air shaft d of adjustable section; below this are a series of smaller openings, also adjustable, through which further air can be admitted; this latter air strikes against the block h, and is heated, while h itself is cooled. The movable cover of the air shaft d supports the shute k^1 which opens just in front of the furnace. The upper end of k^1 embraces the shute k, connected by means of the slide l, which can be set by the crank m, with the conveyor trough o. Two worms n and n^1 are placed in this trough; the second takes up the excess of fuel transported, and carries it back to the starting point, where the fresh fuel is being deposited. An elevator (Fig. 4), actuated together with the worms by an electric motor, takes up the fuel from a funnel shaped trough which feeds as much fuel as all the furnaces connected with the stoking appliance would require at maximum working. The height of the bridge separating the elevator shaft from the conveyor trough is such that this trough, filled up to that height, would satisfy the maximum demand. When not working at full power, or when one of the furnaces is disconnected, the conveyor worm throws back into the elevator shaft the excess of fuel over the normal charge which has been previously fixed. There can hence be no overcharging the conveyor trough, while a deficiency in fuel cannot arise either, as long as the elevator trough is properly attended to.

"The worm keeps the fuel in constant motion. When the coal slide whose projecting edges are scraped by the worm is open, the fuel glides at a constant rate down the shutes k, k^1 into the air shaft d. The slide l is set by means of the crank m; thus the feed is regulated according to requirements. The letters e and e^1 mark sight holes.

"In the space d the coal-dust and air mix. The velocity of the air current, which is to carry the dust into the furnace and not further, is regulated by means of the levers f which raise or lower the cover of the shaft. The quantity of air required for complete combustion is controlled by means of the damper.

"That this arrangement answers, and that only a slight amount of ashes containing little unconsumed coal is carried beyond the firebridge, is proved by the tests which were conducted at the Royal Opera of Berlin during the winter of 1895-6. At the end of the first three weeks, during which 19,900 kilograms of coal-dust were burned, 330.5 kilograms of ashes, *i. e.*, 1.63 per cent. of the material supplied, were found in the flues. At the end of the second period of nine weeks, during which 54,100 kilograms of coal were burned, 650 kilograms, or 1.2 per cent., of ashes were found. These ashes contained only 4.7 per cent. of coal. It was further ascertained by the government inspectors that the gases traveled through the flues with a velocity of 5 or 6 meters (from 16 feet to 20 feet) per second, and that they left the flues at a temperature of 275 degrees C. (527 degrees Fahr.).



The Ruhl Apparatus for the Combustion of Powdered Coal.

"A little wood is lighted to start the boilers. As soon as this is well in glow, the feed of coal-dust is commenced. The dust ignites instantaneously, and the firebricks soon become hot enough to maintain a brisk combustion. After an interruption of an hour or an hour and a half, a little paper or cotton waste will suffice to restart the flame. At intervals of about six hours the cinders have to be removed. For this purpose the coal-slide. the damper and the air shaft have to be closed, when the lower shute k will clear the upper shute k^1. The firedoor c can now be opened. The residue forming a liquid mobile slag, which cools quickly, the mass must at once be raked out, as otherwise it would coat the firebricks. The operation does not require more time than with ordinary grates, however.

"The double worm conveyor is not an indispensable part of this apparatus. Where there are coal bunkers on both sides of large boilers or other furnaces, as on board ship, one conveyor will suffice both for the transport and the feed. This conveyor has then to be supplied with a double gearing so as to act in either direction; the fuel not used will be carried over to the other bunker. The conveyors require about 0.01 horse-power per running meter. The attendance is the simplest imaginable, and the parts are strong enough to insure durability and reliable working."

The economy is given as 22 per cent., but it is not clearly stated whether this saving is in coal alone or includes the economy in labor. Mr. A. Bossig, of Berlin, is introducing the apparatus.

The Trans-Mississippi and International Exposition of 1898.

We learn that the applications for space at the Trans-Mississippi and International Exposition, to be held in Omaha next year, are pouring into headquarters, and that already many excellent and interesting exhibits are assured. Manager E. E. Bruce, of the department of exhibits, announces special prizes, consisting of six gold trophies, six silver cups and six gold medals, to competitors in each of the following classes; for the best display of an irrigation system in operation; for the best electric light service in display; for the best display illustrating the process of manufacture of beet root sugar; for the best display of a manufacturing plant in operation; as well as two more lots of similar prizes for other high-class exhibits to be designated hereafter.

The Chicago & Northwestern Railway has just announced a subscription of $30,000 to the stock of the Exposition. The Burlington road has subscribed $30,000; the Rock Island and Union Pacific will each subscribe $25,000; the Missouri Pacific $20,000, and the Milwauke $20,000. The total stock subscriptions now amount to $438,480, and the promised subscriptions of the railways will raise the total to $528,480. Z. T. Lindsey, manager of the department of ways and means, expects to secure at least $1,000,000 in stock subscriptions.

Congress has appropriated $200,000 to defray the expenses of a national exhibit. The government will erect a great building for its exhibit.

The State of Nebraska will appropriate $200,000, while Omaha and Douglas County will vote bonds in the sum of $200,000 in aid of the Exposition. California will appropriate $50,000. Iowa has appropriated $10,000 and will increase the amount later. Appropriation bills are pending in most of the legislatures in States and Territories west of the Mississippi River.

The exposition site in the northern suburbs of Omaha embraces ample area, is most accessible and in every way adapted for the purpose. The Board of Managers passed a resolution providing for the following nine buildings, which will constitute the nucleus around which the smaller buildings will be assembled:

Building No. 1, Agriculture, Horticulture and Forestry; No 2, Mines and Mining; No. 3, Manufactures and Liberal Arts; No. 4, Fine Arts; No. 5, Electricity and Machinery; No. 6, Auditorium; No. 7, the Nebraska Building; No. 8, Grand Army of the Republic Building; No. 9, the Silver Palace.

The Exposition will open June 1 and close November 1, 1898.

The Great Siberian Railroad and the Present State of its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

According to the preliminary plan of construction of the great Siberian Railroad, outlined by the late Emperor Alexander III. in his rescript addressed in May, 1891, to the Czarewitch, this line was designed as a continuous trans-Siberian railroad.

This line, beginning at Chelabinsk, near the boundary between European and Asiatic Russia, and ending in Vladivostok on the Pacific Ocean, and, together with the system of Russian railroads, destined for connecting the Baltic Sea with the Pacific, was for the sake of facility of construction divided into the following separate lines:

	Miles.
The Western-Siberian Railroad	885
The Central Siberian Railroad	1,149
The Baikal loop line	195
The Transbaikal Railroad	689
The Amour Railroad	1,111
The North Oussouri Railroad	227
The South Oussouri Railroad	252

So that the total length of the railroad in Asiatic Russia was designed to be 4,507 miles, and the total distance from St. Petersburg to Vladivostok, or from Baltic Sea to Pacific, was estimated at 6,232 miles.

The surveys for the Central Siberian, the South Oussouri and the Transbaikal line were made in the years 1887-88, and for the Western Siberian Railroad only in 1891. The surveys of the North Oussouri Railroad were made in 1894, and the construction of the South Oussouri Railroad and the surveys of the Amour Railroad were made only in 1894-95.

The construction of the Great Siberian Railroad has commenced on the South Oussouri line, the beginning of construction being inaugurated by the Czarowitz (now Emperor Nicolas II.) in May, 1891. Then the construction of Western Siberian Railroad began in 1892; that of Central Siberian in 1893 and that of North Oussouri and of Transbaikal in 1894. The Loop Baikal line and the Amour Railroad are not yet commenced, and probably will not be constructed; for instead of the Loop Baikal line a steam ferry through Baikal Lake is designed; and instead of the Amour Railroad—the connection of Transbaikal Railroad with the Pacific will be granted by means of the Eastern China Railroad.

The present state of the different divisions of the Great Siberian Railroads will be explained in the following:

THE WESTERN SIBERIAN RAILROAD.

The Western Siberian Railroad, from Chelabinsk to Obi River, is 886 miles long; it has a branch from Chelabinsk to Ekaterinbourg (making a connection with the Oural Railroad) 148 miles long.

For the purposes of construction this line was divided in two sections: the first from Chelabinsk to Omsk (on Irtysh River) and the second section from Omsk to Obi River. The first section was begun in 1892, and the rails were laid in 1893 and 1894. The second section was begun in 1893, and the rails were laid in 1895. In order to meet the wants of the local population the traffic was opened before the finishing of the line; on the first section (Chelabinsk Omsk) in September, 1894, and on the second section (Omsk-Obi River) in October, 1895.

In October of 1896, a commission appointed by the Minister of Way-of-Communications inspected the Western Siberian Railroad, and decided that it would be opened for regular passenger and freight traffic in that month October, 1896.

The construction of the Chelabinsk-Ekaterinbourg branch began in August, 1894, and the track laying was ended in November, 1895, and in December the railroad was ready for provisory traffic.

The total cost of the Western Siberian Railroad was estimated as follows:

The first section, from Chelabinsk to Omsk	$13,412,000
The second section, from Omsk to Obi River	10,275,000
Total cost with rails and rolling stock	$23,685,000

Viz., $26,730 per mile.

The total cost without rolling stock was estimated $19,383,000
from which sum the Chief Engineer has effected $234,250 of economy.

The cost of construction of the Chelabinsk-Ekaterinbourg Branch (148 miles) was estimated, without rolling stock (to be furnished by the Oural Railroad), $3,238,000, viz., $21,900 per mile, and this sum has sufficed for the finishing of the branch.

The construction of the Western Siberian Railroad was completed in October, 1896, with the exception of the bridge through Obi River and the central repairing works in Omsk, which constructions will be finished in the summer of 1897.

The construction of the Chelabinsk-Ekaterinbourg Branch was finished in the end of 1896, and the operating of that line is transmitted to the Oural Railroad, which in this way is connected with the network of Russian railroads.

The Western Siberian Railroad is quite finished—that is, it is constructed according to the original design; but the early development of the passenger and freight traffic has shown the necessity of additional works, namely, the enlargement of many passenger stations, the addition of houses for railroad employees, the addition of sidings and freight sheds at stations with great freight traffic and the increasing of the thickness of the ballast on 120 miles in marshy grounds on the second section of the railroad. All this additional work will be carried out under control of the operating administration.

The Western Siberian Railroad has encountered many perplexities in the matter of water supply and the supply of fuel, and the satisfactory solution of these questions has presented many difficulties.

The country crossed by the line of the Western Siberian Railroad (nearly following the circle of 55 degrees north latitude) consists of two great plateaux—the Ishim plateau (steppe) and the Baraba plateau (steppe). The surface is level, and has only small local depressions of ground, forming the lakes, very often filled with salt water. On the whole space between Chelabinsk and Kainsk the line only crosses three great rivers, Tobol, Ishym and Irtysh; on the section Kainsk-Obi River, only the secondary rivers (Karhat, Chulin, Chik) are met. Between Chelabinsk and Irtysh River, and especially between the rivers Ishym and Irtysh, the line is located over salt grounds with many salt lakes. Between the rivers Irtysh and Obi in the Baraba steppe the salt ground is met only in neighorhood of Kainsk, where the northern region is covered with marshes and salt lakes.

In consequence of scarcity of flowing waters, and the unavailability of salt water furnished by the greatest part of the lakes, the water supply of railroad stations was not easy, and on many occasions, the builder was obliged to seek the subground water, and bore artesian wells.

Of the 32 water stations, eight water supplies have artesian wells, the depth of which varies from 273 feet to 651 feet, and the diameter from 4 inches to 12 inches.

All the artesian wells are of the non-flowing type and use the sub-artesian water (at the depth of about 280 feet); for the deeper boring in Karagugu to the depth of 910 feet has shown that though the water from that depth rises to the surface of earth, it is too hard and bitter and cannot be used. The sub-artesian water supplied by all the eight wells is still very hard and must be purified by chemical means (addition of lime and soda). In addition to those mentioned there were sunk in the latter part of 1896 five supplementary water supplies midway between the original stations which were found to be too far apart (more than 33 miles).

Notwithstanding this, having in view the scarcity of flowing water and the insecurity of lakes, we can expect that in the near future, with the development of traffic, the water supply of the Western Siberian Railroad will be found unsatisfactory, and the administration will be obliged to increase the number of artesian wells. Another very difficult and important question was the supply of fuel. On the whole length of the Western Siberian Railroad there are no forests, no collieries, no turf deposits, no oil pits. The great coniferous forests begin only on the other side of the Obi River, outside of the terminus of the line. All the fuel must be carried from long distances.

The fuel used in the first years of the operating period will be coal for the first 240 miles (from Chelabinsk to Makushino) and wood for the balance of the line. The coal will be supplied from the Lunenetz colliery in the Oural Mountains at the price of $4 per ton in Chelabinsk. This coal is of such quality that one ton of it is equivalent to 170 cubic feet of wood. This ratio was the basis for calculations, which have shown that now wood is more economic fuel than coal. There are great coal deposits on the left shore of Irtysh river, not far from Omsk, but they are not yet explored, and their availability is not proved.

The wood for the following 421 miles of the Western Siberian Railroad, from Markshino to Kainsk will be supplied in the great forestry region, belonging to the state, on the right shore of Irtysh River, and crossed by its tributaries Tora, Oui, Shish and Toui. The area of this region is about ten million acres, and will give 10,000,000 cubic feet wood yearly. The distance of this forest region from Omsk is about four hundred miles, and the wood will be carried by means of a river fleet belonging to the administration of the railroad and consisting of two steamers and 12 barges.

The last 187 miles of the line, from Kainsk to the Obi River, will be supplied with wood prepared on the other side of Obi River, this wood being cheaper than the coal from the Kuznetzk colliery on Tomi River.

Of course wood as fuel cannot be indefinitely used, and with the development of traffic (which now presents only three trains daily in each direction), the mineral fuel will be obligatory, and we can hope that suitable collieries not far from line will be found.

We trust that the following general data, concerning the first period of operating the Western Siberian Railroad will be of interest.

From September, 1, 1894, to the 1st of July 1896, (22 months) the traffic on the division Chelabinsk-Omsk is shown by following figures:

Passengers I., II., III. and IV. class	152,315 persons.
Settlers	189,606 "
Workmen and soldiers	33,000 "
Exiles	2,258 "

In addition to the above is the luggage of passengers and settlers.

From October 1, 1895, to July 1, 1896 (9 months) the traffic on the division Omsk-Obi River was:

Passengers I., II., III. and IV. class	37,540 persons.
Settlers, workmen and soldiers	116,026 "
Exiles	1,405 "

From December 1, 1895, to July 1, 1876 (7 months) the traffic on the Chelabinsk Ekaterinbourg branch was:

Passengers I., II., III. and IV. class	23,768 persons.
Settlers, workmen and soldiers	3,072 "
Exiles	2,409 "

The whole freight traffic on the Western Siberian Railroad and its Ekaterinbourg branch was about 200,000 tons.

The total receipts for the transportation of passengers and freights were $1,324,000, which will probably cover the working expenses.

In conclusion, we should remember that the Western Siberian Railroad, being located in a quite level country, has a very easy profile of track. The ruling gradient in the eastward direction is 0.0074, in the westward direction 0.0069. The length of level track is about 500 miles, or 56.5 per cent. of the whole. The percentage of gradients in the eastward direction (from Chelabinsk to the Obi River) is as follows: Less than 0.003, 11 per cent. of the whole; from 0.003 to 0.004, 2.7 per cent.; from 0.005 to 0.0074, 6.7 per cent. The percentage in the westward direction (from Obi River to Chelabinsk) is: Less than 0.003, 13 per cent.; from 0.003 to 0.004, 3 per cent., and from 0.005 to 0.0069, 7.7 per cent. The minimum radius of curvature is 1,400 feet and the greater part of the line is straight, the total length of curves making only 7½ per cent. of the whole.

(To be continued.)

The Gates Iron Works.

The Gates Iron Works, Chicago, several years ago initiated its policy of gradually rebuilding its entire plant by the erection of a building 78 feet by 325 feet, which is intended ultimately for an erecting shop, but at present is occupied almost wholly as a machine shop. It is a fine building for the purpose, having plenty of light, and being well heated and ventilated. The offices are in this building, occupying two floors at one end, and a gallery along the north side. The drawing-room is also on this gallery and the north exposure, with plenty of windows on that side of the room, makes one of the pleasantest and best lighted drawing-rooms we have seen.

Except for the gallery mentioned there is only the one floor under this roof. It is served by a traveling crane, built by the Morgan Engineering Company. The shop is heated by the Buffalo Forge Company's hot blast system. The power for the machine shop is furnished by electric motors. Four motors are so placed as to drive that many groups of tools, one motor driving the planers, another the lathes, a third the boring mills, etc., and the fourth furnishes power for the tool-room. The dynamos are in the engine-room, which is a separate building and supply current for various purposes throughout the entire plant. For night work, when a few tools only are operated in the machine shop, the blower engine of the heating system is made to furnish the power. It is in the shop and so arranged as to be quickly connected up.

In the course of a recent tour through the shops we noticed a number of interesting things. The tool-room is well equipped and is located under the gallery and directly beneath the drawing-room. A two-story vault gives fireproof storage for the tool-room and drawing-room. The second floor is used for the safe keeping of valuable drawings, while the first floor is occupied by gages and templets of various kinds. When one thinks of the immense sums that are locked up in templets, gages and special small tools required in a first-class shop, the construction of a vault for their safe keeping will appear as a most natural precaution. And yet this is seldom done; in fact we do not remember to have seen it done before. The company figure that they have more money invested in the contents of this vault than in any space of the same size anywhere about the plant.

We noticed an ingenious grinding attachment for a lathe, which consisted of a small grinder driven by a diminutive electric motor, the whole device being self-contained and mounted on the cross-slide of the carriage. It can be quickly attached to any lathe, and besides using it for miscellaneous grinding operations it is employed for truing up all lathe centers and arbors.

The work done in this company's foundry is of a most interesting character. Not only are many heavy castings of various shapes turned out, but in their ore and rock crushers, rolls, etc., there is needed a very hard material. Manganese steel and other special mixtures have been tried for crusher jaws, but more or less difficulty has been found with them, and the company has concluded that the best results can be obtained from chilled cast iron. These crusher jaws must be so made that they can wear five inches of metal from their faces before being discarded, and consequently the depth of chill must be at least equal to that figure. We saw some castings that had been broken under the drop and whose fracture showed a chill between five and six inches deep. This result has not been obtained without much special investigation and study. A laboratory adjoins the main foundry, room and in it is placed a small test cupola, where special mixtures are melted and the qualities of the resulting metals tested. The company also has what it calls its gear mixture, used for gears and castings that must stand equally hard usage, and one-inch test bars cast from this metal must show a strength of 3,000 pounds when placed on supports 12 inches apart. They actually average about 3,500 pounds, but they would be rejected if they fell below 3,000 pounds.

The foundry floor is served by a Yale & Towne traveling crane, which is believed to be the first built by that concern. It has in recent years been supplied with electric motors.

The Gates Iron Works has recently added to its line of products the Fischer engine, as already noted in the pages of this journal. Several sizes of this engine were on the floor in a partially completed state at the time of the writer's visit. The engine business is not a new one to the company, as it has for years built an engine of the Corliss type for parties who were willing to pay for a high-grade engine. It is preparing to do a large business with the Fischer engine.

The publishers of the Official Railway Equipment Register and the Pocket List of Railroad Officials announce that increased facilities having become necessary, the publication offices have been removed from Pearl street to Room 17, 24 Park place, New York City.

The tests made with liquid fuel on the Russian torpedo-boat *Viborg* during October, 1896, proved so satisfactory and showed such advantages that all torpedo-boats having locomotive boilers are to be fitted to burn *masut* as well as coal. The torpedo-boats having water-tube boilers will not be so fitted until tests have been made on the six boats now building, and which are to have Du Temple boilers fitted for liquid fuel. Part of the present coal bunkers will be arranged into compartments which will have a capacity of 3.25 tons of *masut*. The trials on the *Viborg* showed that it was very important to give special attention to the first filtration of the *masut*.—Journal of Amer. Soc. Naval Eng.

The Barnes' Feed-Water Heater for Locomotives.

In the accompanying illustrations we show the construction of a feed-water heater designed by Mr. J. Barnes, Superintendent of Motive Power of the Wabash Railroad, and used by him on the locomotives under his charge. It is, in brief, a method of utilizing the exhaust steam from the air-brake pump for heating the water in the tank. The amount of steam used by a pump is considerable, and it appears from actual experience that the heat recovered by turning that steam into the tank is sufficient to make the water as hot as the injector can work it. In writing to us about it Mr. Barnes says:

"The feed-water heating arrangement is very simple; it consists of a three way valve in front of the pump, a lever controlling the direction of the exhaust, putting it into the stack or into the tank, a 1¼-inch pipe running in both directions from the valve to stack and from valve back into tank through the separator, and steam hose and connection as shown by print. The purpose of the separator shown is to catch any oils or other foreign matter which would otherwise be carried into the boiler through the feed water. It can be readily blown out two or three times a trip, as occasion may require. The use of this device is merely precautionary. Around the bottom of tank lies a 2½-inch pipe with 15 upright pipes with Tee connections, all of the same dimensions as the horizontal pipe mentioned. At the end of each vertical pipe is a goose-neck attachment with a reduced nozzle ⅛ inch in diameter (see Fig. 3) except the last one at the end of horizontal pipe, which has a nozzle attachment of one inch in diameter. The object of the larger opening in the one pipe is to induce the exhaust to follow the horizontal pipe to the end, carrying with it the condensation falling from the other upright pipes with the smaller openings, which smaller openings are for purpose of assisting in giving vent to the exhaust and keeping the uprights heated. Should the water become too warm for the injector, the operator easily turns the exhaust into the stack. The water in tank can be heated to 100 degrees Fahr. and more. Any injector of modern make will readily work at that temperature. As the water recedes in the tank, less heating surface is in contact with water, hence the tendency is for the water to remain at an even temperature.

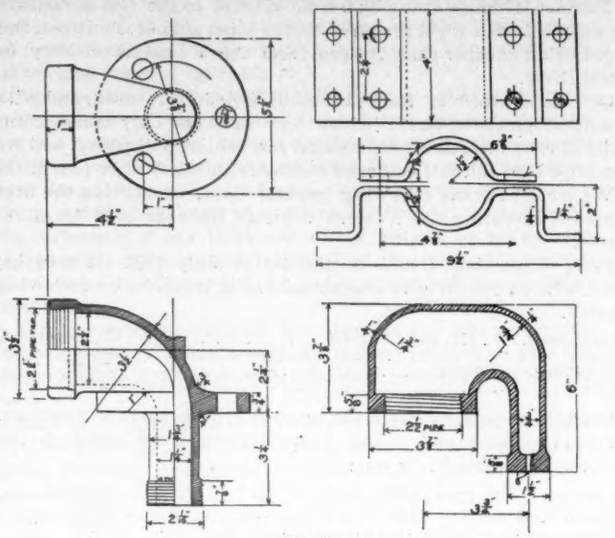
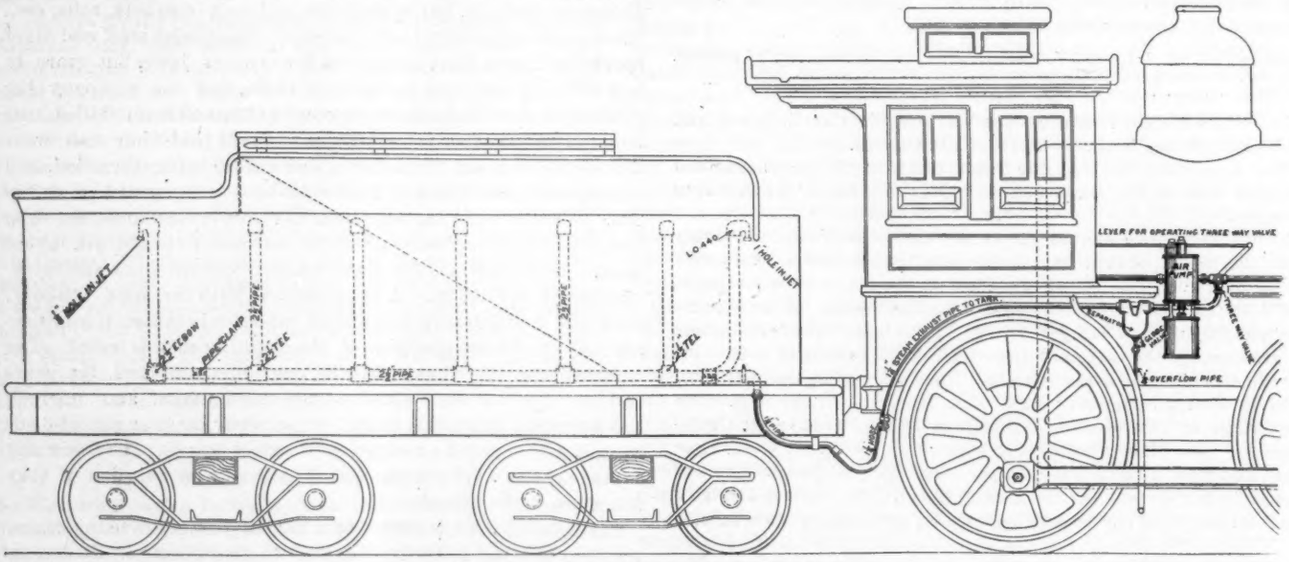


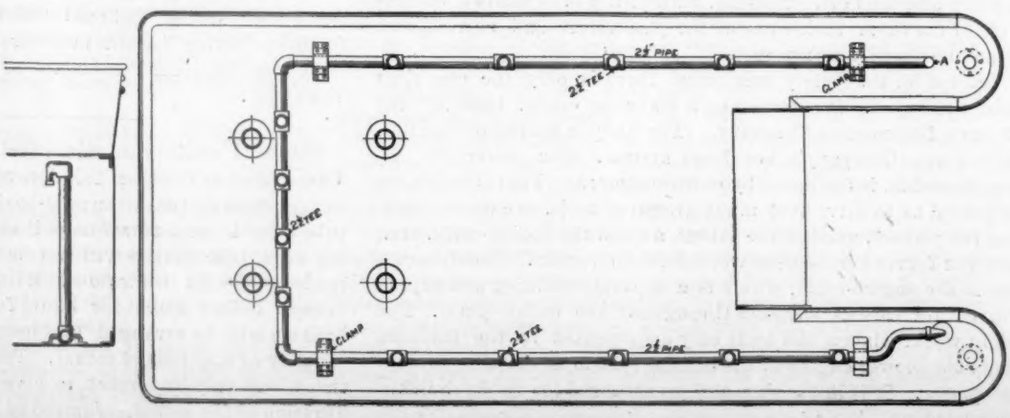
Fig. 3.



The Barnes Feed-Water Heater.—Fig. 1.

"There is no question as to great results from this device as a fuel economizer. Then again its practical utility in diverting the steam pump exhaust from the front end into the tender is simply getting rid of a nuisance at no expense, and putting it where it is of real benefit, in addition to the great saving in fuel."

A patent has been applied for on this device and already quite a number of roads are arranging to use it. It certainly appears to be one of those things which, without adding a complication of parts, reduces the waste of fuel in one direction to a minimum.



The Barnes Feed-Water Heater.—Fig. 2.

The Pyle-National Electric Headlight.

The manufacture of electric headlights must, in even a greater degree than the makers of other first-class machinery, combine in their apparatus, simplicity, reliability, efficiency and the minimum of bulk, cost and maintenance. Many railroad officers are in favor of electric headlights, but are looking for a simple and less expensive mechanism than has yet been offered them.

The improved electric headlight patented by Mr. Geo. C. Pyle, and placed on the market by the Pyle-National Electric Headlight Company, of Chicago, presents these desirable features to a greater degree than any headlight in the market. Its general appearance and special features are shown in the accompanying engravings, in which Fig. 1 is a section through the dynamo and motor, Fig. 2 is an exterior view, Figs. 3 and 4 are views with parts of the casings removed, and Fig. 5 is a view of the lamp. The current-generating apparatus consists of a compound steam turbine and a dynamo mounted on the same shaft and occupying a space only 26 inches by 18 inches wide. This is mounted on the smokebox between the headlight and the stack, the space required being 19 inches.

The turbine is an interesting piece of mechanism. It consists of a casing in two parts, *A* and *B*, Fig. 1, within which is the disk *C*, mounted on a shaft $1\frac{11}{16}$ inches in diameter. The steam is admitted at *D*, and by means of four ports passes to the buckets *E*. The disk has five series of buckets, *E*, *F*, *G*, *H* and *I*, against which the steam acts before it is exhausted. The shape of these buckets was determined after careful experiment, and as a result the two outer series, *E* and *F*, are curved, while the others are straight and are set at an angle of 45 degrees. The clearance between the buckets and the fixed deflectors is $\frac{1}{10}$ of an inch. The steam after leaving the last bucket escapes through an exhaust pipe attached either at *J* or J^1, and leading into the stack or the smokebox, as desired. The governor is simple and ingenious, and is said to be very effective. It consists of a thin ring, *K*, adapted by a lateral movement to throttle the steam at the openings by which it enters the buckets *E*. The ring is held in position by four flat springs *M* (seen in Figs. 1 and 3), whose tension is adjusted by screws. The ring is also acted upon by four small weights, *L*, so placed that their centrifugal force acts in opposition to the springs. When running at normal speed the balance between the weights and springs keeps the ring in a position to give the required steam admission, and if the speed begins to change the force of the springs or the weights shifts the ring to meet the conditions and keep the speed within close limits. The normal speed is 1,900 revolutions and the regulation is within 25 revolutions between full load and no load.

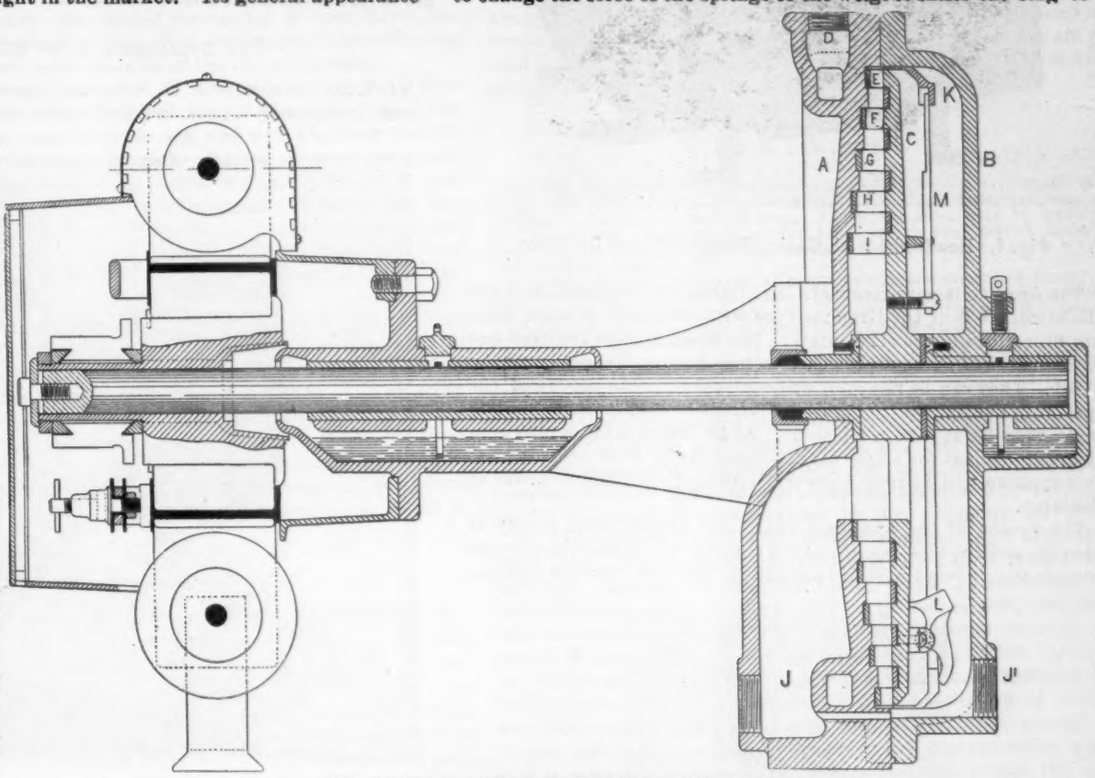


Fig. 1.—Section Through Turbine and Dynamo.

The steam pressure employed is about 25 pounds under the boiler pressure and a ¾-inch pipe furnished the supply. The exhaust pipe is 1¼ inches in diameter. The combined area of the four steam ports is less than the area of a ¼-inch pipe.

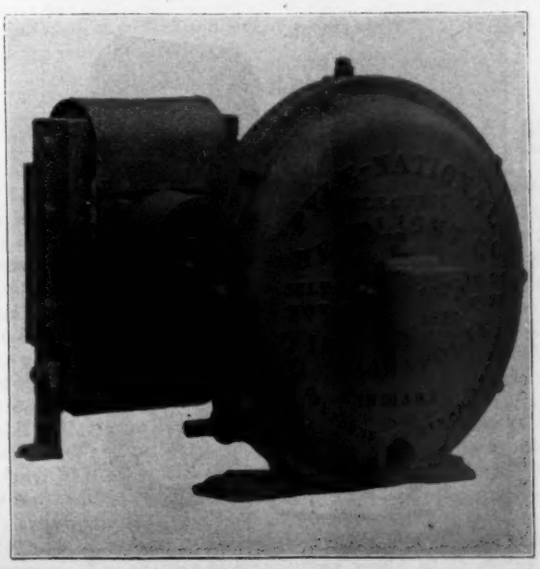


Fig. 2.—The Pyle-National Electric Headlight.

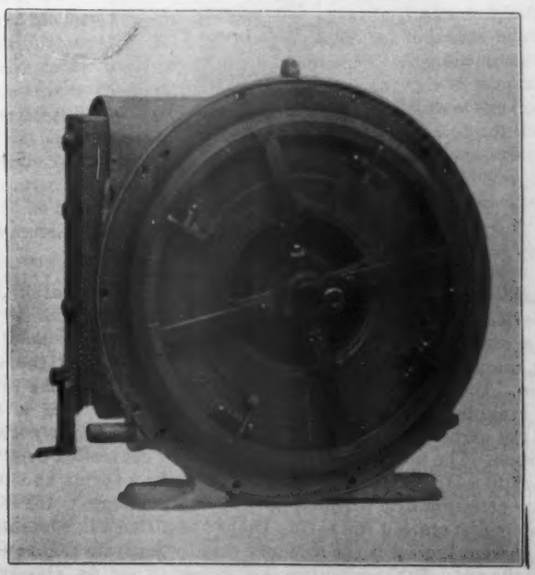


Fig. 3.—Headlight With Casing Removed From Turbine.

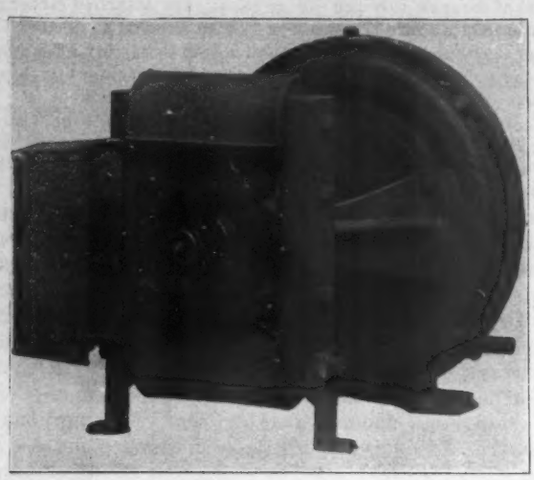


Fig. 4.—Headlight With Casing Removed From Dynamo.

The dynamo is very compact. The frame is of wrought iron and the armature is of the Gramme type with 240 turns of wire; there are 40 sections to the commutator. The brush holders are fixed and one brush is of pure graphite, while the other is a regular carbon brush. They can be removed without changing the tension of the springs. The dynamo generates a current of 25 amperes at 30 volts when running at 1,900 revolutions. As 450 watts are generally considered sufficient for a 2,000 candle-power lamp, it is evident that this dynamo will furnish between 3,000 and 4,000 candle-power at the lamp.

The weight of the armature, shaft and turbine disk is only 41 pounds, and the total weight of the turbine and dynamo is only 250 pounds as compared with 780 pounds in the old types of electric

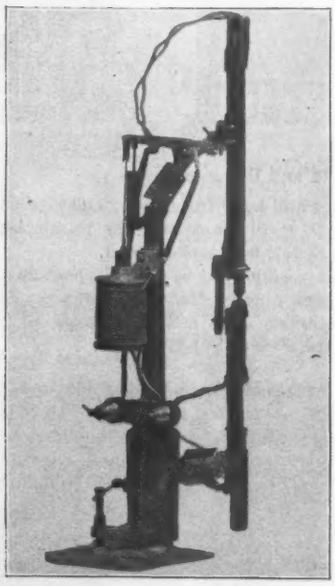


Fig. 5.—Lamp for Pyle-National Headlight.

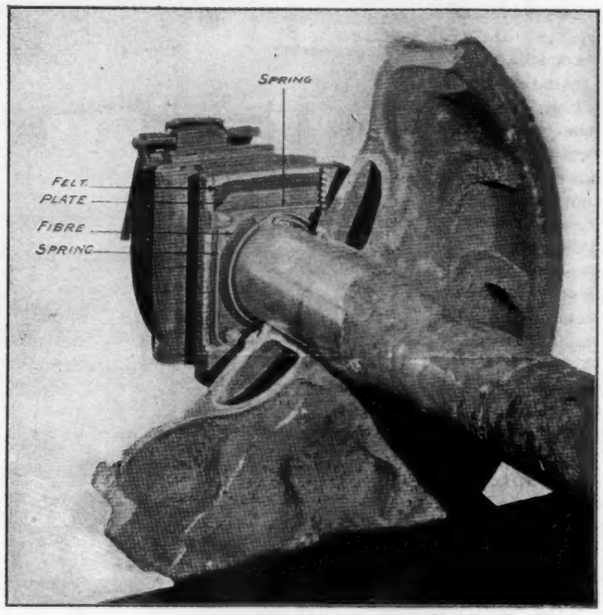
headlights. The bearings are of bronze and the lubrication is as near perfect as is attainable.

The arc lamp is shown in Fig. 5. The lower carbon is held by a spring against a stop so that its upper end is always in the same position. The upper carbon passes through a ring, the hole in which is slightly larger than the carbon. When the ring is horizontal the carbon can slip through it, but if tipped slightly it holds the carbon. The movements of the ring are controlled by a wire attached to a lever actuated in one direction by a spring and in the opposite direction by a solenoid in the lamp circuit. When the dynamo is first started the spring keeps the carbons in contact, but as the current increases the solenoid acts to separate them and establish the arc. The mechanism is designed to use up almost the entire length of the carbons and one set of them will last about eight hours. The cost for carbons is under two-tenths of a cent per hour.

The improved light has been in use for over a year on the Wilmington & Northern, the Plant system, the Vandalia and the Big Four roads, and on the Chesapeake & Ohio since November, 1896. The light has proved to be very steady and satisfactory in every respect. The cost of maintenance has been reduced to a remarkably low figure, and the first cost is only about one-half the price at which the earlier headlights were quoted. Mr. Royal C. Vilas is President of the company; Mr. G. C. Pyle, Electrician, and Mr. Mark A. Ross, Sales Agent. The offices of the company are in the Monadnock Block, Chicago, Ill.

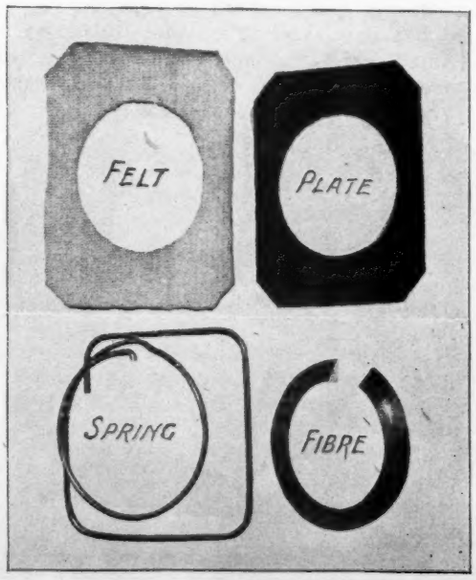
The Symington Dust Guard.

Mr. T. H. Symington, M. E., Assistant Superintendent of the Richmond Locomotive Works, has had in service for some time past a



The Symington Dust Guard.

dust guard of his own invention, and for which excellent results are claimed. We show the dust guard in the accompanying illustrations. It consists of a piece of $\frac{1}{16}$-inch iron, backed by a similarly shaped piece of felt. A ring of flexible vulcanized fiber is pressed against the plate by a spiral spring of $\frac{1}{4}$-inch steel wire, which spring



The Symington Dust Guard.

also presses against the rear wall of the dust guard slot or pocket in the journal box. This pressure holds the felt against the surface of the front wall of the pocket. Joints are thus maintained between the plate and the box, and between the ring and the plate.

The spring pressing on the beveled side of the fiber ring produces a slight but constant pressure tending to close the ring on the axle, thus giving a tight joint all around the axle. A length of 2 inches is cut out of the ring on top of the axle, allowing it to close about ¾ of an inch as it wears. Where the opening in the ring occurs, the plate rests lightly on the axle and completes the joint. The spring is prevented from turning in the dust guard pocket by having its outer coil made square. One end of the spring is bent down between the ends of the fiber ring, thus preventing it from turning and keeping the opening in the ring at the top of the axle.

To apply the dustguard, the felt is first put in the slot; then the iron plate, which is bored $\frac{1}{16}$-inch larger than the axle. The spring is then compressed in the hands, and with the ring pushed into place through the top of the slot. A piece of wood or iron is then put between the ends of the fiber ring holding it open $\frac{1}{8}$-inch larger than the axle, and is pulled out through the top of the slot after the box is put into place. The ring is then closed on the axle by the spring. Roundhouse men have found it easier to apply than the ordinary guard, because the hole is $\frac{1}{16}$-inch larger than the axle, when the box is being put in place.

After 18 months' continuous running, an axle having this guard applied to it was carefully examined, and no mark could be found where the plate or spring touched it, nor was there any appreciable wear of the plate. The plate was worn $\frac{1}{16}$-inch larger than its original size. The brasses were carefully weighed before and after the test. A saving of 46 per cent. in wear of bearings was shown with the Symington Guard over the ordinary guard on the same truck. The saving of oil and protection against hot boxes may be inferred. The price of the guard is stated to be about 20 cents.

A Large Rand Compressor.

A recent issue of a Canadian paper contains an interesting dispatch from Rossland, B. C., regarding the christening and starting up of a large Rand compressor recently installed in the Le Roi mine at that place. The compressor will be known as the "Senator" and will be used for running all the pumps and hoists at the mine in addition to operating 40 drills. It is described as a beautiful piece of mechanism in every detail of its construction and is fitted with the latest type of mechanical air valves, automatic governors, etc. It has the distinction of being one of the three largest compressors in use in the great Northwest. The machine is a Rand air compressor of the latest improved type with Corliss compound condensing engine; size of steam cylinders 22 and 40 by 48 inches stroke; air cylinders, 22 and 34 by 48 inches stroke, with intercooler.

The Rand Drill Company, 100 Broadway, New York, builders, reports a steadily increasing demand for their compressors and drills for mining purposes, and claim that they make the most efficient, economical and durable machines for this class of work on the market.

New Publications.

POWER DISTRIBUTION FOR ELECTRIC RAILROADS. By Louis Bell, Ph. D. Street Railway Publishing Company, 26 Cortlandt street, New York, 1897.

In this volume the author has endeavored to set forth the general principles of the distribution of electrical energy to moving motors, to describe the methods which experience has shown to be desirable in such work, and to point out the way in which those principles and methods can be co-ordinated in every-day practice. He believes the apparatus employed is for the most part too mutable to describe exhaustively, unless one is writing history, and hence he gives little of such detail in this work. Some idea of the scope of the work can be obtained from the titles of its chapters, which are as follows: I, Fundamental Principles; II, The Return Circuit; III, Direct Feeding Systems; IV, Special Methods of Distribution; V, Sub-stations; VI, Transmission of Power for Sub-stations; VII, Alternating Currents for Railway Work; VIII, Interurban and Cross-Country Work; IX, Fast and Heavy Railway Service.

The book is most interestingly written and is up to date in every respect. The chapter on inter-urban roads, while giving considerable attention to narrow gage and single rail lines, makes clear the important part which electricity can take in the development of localities by means of light and comparatively cheap lines of transportation. The chapter on fast and heavy railway service does not deal so much with electricity in general railway work as it does to the following three special cases: 1. Heavy local passenger traffic; 2, high speed inter-urban traffic; 3, elevated roads, tunnels and special service. The general principles of such transportation and the details pertaining to it are discussed. The power required, the features of line construction and such data as is necessary to determine the cost in any given case are presented in a clear manner. The author discusses a case of traffic at 100 miles per hour in which the train resistance, air resistance and other factors in the problem are given positive values with a freedom that a steam railroad man would envy. The figures may be right, but no one in steam railroad practice is sure of it. On the whole, however, the subjects are treated in a manner beyond criticism.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

AUTOMATIC HOISTING AND CONVEYING APPLIANCES. Brown Hoisting and Conveying Machine Company, Cleveland, O. 76 pages, 5¾ by 10½. (Not standard size.)

This company designs and manufactures special machinery of all kinds for handling materials in large engineering undertakings and manufacturing processes, and ore, coal, etc., from vessels, docks and mines. The company is the sole proprietor of the patents on the mechanical devices invented by Mr. Alexander E. Brown, C. E., the Vice-President and General Manager, and also of the patents on cranes formerly controlled by the Yale & Towne Manufacturing Company, of Stamford, Conn., whose entire crane business was purchased by the company in December, 1894, and added to their crane department. This catalogue is issued from the company's Western office, in Chicago, and illustrates such a variety of machinery that it is difficult to give it an adequate mention in a notice of this kind. Almost every large installation of hoisting and conveying machinery has been adapted to meet special conditions and consequently differs more or less from all other plants. It is in meeting the requirements of each situation that the enterprise and engineering ability of this firm has gained such a marked recognition everywhere.

Most of the engravings, of which there are about 30, are full-page illustrations of notable installations. The first of these is a movable bridge tramway hoisting and conveying apparatus for coal and ore on the C. & P. R. R. docks at Cleveland. Another is five-span cable tramway apparatus on the N. Y., P & O. dock in the same city. Cantilever cranes of various kinds are also illustrated, including those used on the Chicago Drainage Canal, with arms extending over 350 feet, and others used in ship yards, docks and in industrial establishments. Bridge traveling cranes, movable bridge tramways cable tramways, shed tramways, movable tramway systems for sewer construction, and traveling cranes of many kinds are described and illustrated. A valuable feature of the book is that it not only gives the dimensions and rated capacities of the various plants, but in many cases gives the quantities of material actually handled per day, week or month in actual service. The catalogue will be found of interest and value by all who are concerned in the economical handling of materials of any kind.

REFRIGERATION, AND THE MACHINERY TO DO IT IN THE MOST RELIABLE AND ECONOMICAL WAY.—Westinghouse, Church, Kerr & Company, Engineers, New York, Pittsburg, Boston, Philadelphia and Chicago. 24 pages, 6 inches by 9 inches. (Standard size.)

This interesting pamphlet opens with a caution to "start right' when getting a refrigerating plant. "A good compressor is the main root of good refrigeration; but it is only one root. Refrigeration, perhaps more than any other mechanical process, must be good at each step to be profitable, and the machinery by which it is handled must be as perfect as the results desired. A poor compressor will spoil the best job ever put up, while a perfect compressor is almost worthless when attached to improperly designed or poorly constructed piping. The refrigerating plant as a whole is a poor investment unless it is backed by reliable insulation to keep the heat out of the places it has cooled.

"It is one thing to produce good refrigeration and another to

keep it. Suppose a box built without any doors had walls so perfectly insulated that no heat could get through them. If cooled down to freezing it would stay there forever without further refrigeration. No insulation is perfect, so some heat always works through and the size of the refrigerating plant and the cost of running it depends largely on how much heat gets in. You can't have insulation too good. It saves money. Purchasers sometimes wonder why refrigerating plants scatter through such a range of price. The reason is that some contain only poor work and inferior machinery, others are partly good, while some are strictly first-class throughout. If refrigeration is worth doing at all, it is worth doing in a substantial, efficient way, insuring a durable plant and a money-saving service."

The requirements of a good ammonia gas compressor are then outlined and the independent, self-contained compressor furnished by this firm is described and illustrated. This compressor is usually belt-driven and the pin of the crank on the main shaft works in a yoke to which two single-acting pistons are attached. There are two cranks and four cylinders in the larger sizes and one crank and two cylinders in the smaller ones. In their construction and in the details of design they are as near perfect for the work required as it is possible to make them.

The condenser advocated by this firm is one of their own design. It is vertical, made in sections of about one ton capacity, and with this unit any size can be built up. Each section is a row of pipes with top and bottom headers. The water flows in a thin film down each pipe without spattering, and by the thinness of the film great economy in water results, as some is vaporized, which action is increased by the upward currents of air, making it in part an evaporative and air condenser. This is of much importance where the water supply is limited or expensive, as in cities. The condenser may be in or out of doors, usually the latter, where it occupies room of no value, and in cool weather requires little or no water.

Some space is given to the character of pipe and pipe fittings necessary for good work. The fact that refrigerating is high-class work from an engineering and scientific standpoint is also rightly insisted upon. The pamphlet contains many full-page engravings of excellent quality, showing clearly the principal features of a number of interesting plants. The New York office of the company is at 26 Cortlandt street.

AIR-COMPRESSORS. The Ingersoll-Sergeant Drill Company, Havemeyer Building, New York. 64 pages, 6 by 9 inches. (Standard size.)

This neat catalogue is really the advance sheets of Catalogue No. 31, and is devoted entirely to air-compressors, if we except the few pages at the back, on which air-receivers, tanks and reheaters are illustrated. The compressors illustrated include almost every conceivable type—straight-line, single, compound, duplex, half-duplex and triple—and driven by steam, electricity, Pelton wheels, turbines, belts or gears. The company has had an experience of over 25 years in the manufacture of compressors, and those years have been years of great progress in the devolopment of this class of machinery, to which this company has contributed its full share. The excellence of their work may be judged by the engine friction as ascertained by Professor Jacobus at the World's Fair, which was found to be less than five per cent.

It would be impossible in the limits of our space to describe the many designs of compressors illustrated in the catalogue. Those who want to study them should send for copies for themselves. We would mention particularly, however, the class "G" compressor, which is quite extensively used in railroad shops. It is a duplex machine, but is also furnished as a half duplex. It is possible, also, to install the half-duplex and purchase the other half when the demand for air has increased sufficiently to require it. These compressors have piston inlet air-cylinders, water jackets on both barrel and heads of the air-cylinders, and are provided with a governor, an automatic pressure regulator and an unloading device on the air-cylinders.

The catalogue is of value to all who are interested in air or gas compression to any pressure and for any purpose whatever.

The Strength of Culvert Pipe.

The Blackmer & Post Pipe Company, of St. Louis, manufacturers of culvert and sewer pipe, recently decided to test the external pressure its large sizes of pipe would stand without breaking, and believing that reliable information would be desirable in making comparison of the merits of brick sewers and pipe sewers, it selected from the stock on our yard the following material: Two sections 24-inch double strength culvert pipe; two sections 27-inch double strength culvert pipe; two sections 30-inch double strength culvert pipe; two sections 27-inch standard culvert pipe; one section 30-inch standard culvert pipe. This material was sent to the works of the Geo. J. Fritz Foundry and Machine Company, 2038 South Third street, St. Louis, where each section of pipe was tested in the following manner: In making the tests blocks of wood were hollowed out to fit as nearly as practicable the shape of the pipe, each block covering a little less than one-fourth the circumference of the pipe. The pipe was then placed in an hydraulic press, the power being supplied by a hand pump, the pressure being registered on the gauge as applied. Inasmuch as the blocks were of hard material, and it is extremely difficult to make them conform exactly to the contour of the pipe when pressure is applied, the results of the tests can hardly be called a fair or full measure of the strength of the pipe, but the resistance of the pipe as shown clearly proves its strength to be more than sufficient for its legitimate use. Indeed, when the pipe is properly laid, with its entire lower surface solidly bedded in the ground, it would appear, in the light of the foregoing tests, that the pipe could not be broken by the weight of earth above it, no matter how deep the cut.

The actual results of the tests were as follows:

One section 24-inch double-strength culvert pipe, 2 inches thick, broke at 27,610 pounds.

One section 24-inch double-strength culvert pipe, 2 inches thick, broke at 28,715 pounds.

One section 27-inch double-strength culvert pipe, 2¼ inches thick, broke at 33,133 pounds.

One section 27-inch double-strength culvert pipe, 2¼ inches thick, broke at 32,763 pounds.

One section 30-inch double-strength culvert pipe, 2⅛ inches thick, broke at 27,987 pounds.

One section 30-inch double-strength culvert pipe, 2⅛ inches thick, broke at 24,297 pounds.

One section 27-inch Standard culvert pipe, 2⅛ inches thick, broke at 23,986 pounds.

One section 27-inch Standard culvert pipe, 2⅛ inches thick, broke at 22,530 pounds.

One section 30-inch Standard culvert pipe, 2¼ inches thick, broke at 27,875 pounds.

The Steel-Tired Wheel Company.

The Steel-Tired Wheel Company, which was incorporated in New Jersey in January, with an authorized capital of $4,000,000, has purchased the plants, materials and business of the Allen Paper Car-wheel Company, the Boies Steel Wheel Company, the McKee, Fuller and Company, the Page Car Wheel Company, the Ramapo Wheel and Foundry Company, and the Washburn Wheel Company. The Krupp wheel business, as represented by Messrs. T. Prosser & Sons is independent of the new company, as are also the Standard Steel Works and the Taylor Iron and Steel Company. The officers of the new company are: President, J. E. French, formerly of the Paige Car Wheel Company; First Vice-President, W. W. Snow, of the Ramapo Wheel and Foundry Company; Second Vice-President, C. H. Antes, formerly of the Allen Paper Car Wheel Company; General Manager, W. W. Silverthorn, formerly of the Paige Company; Treasurer, J. C. Beach, formerly of the Allen Company; Secretary, W. W. Turlay, formerly of the National Car Wheel Company. The Directors of the new company are the officers above, also H. M. Boies, of the Boies Steel Wheel Company, and W. M. Barnum.

It is expected that the new company will be able to reduce the prices of wheels to consumers, not so much through a reduction of the cost of manufacture as in the saving of administrative expenses and the cost of selling, which can be greatly reduced under the new arrangement. The wheel works purchased by the company will continue to be operated. The offices of the company are in the Boreel Building, 115 Broadway, New York.

Paint for Metal Surfaces.

The evidence is accumulating in favor of graphite paint as the paint of the future for the protection of all exposed iron and metal work. Professor Spennrath, Director of the Technical School of Aix-la-Chapelle, lately won the $2,000 prize offered by the Society for the Advancement of the Industrial Arts for the best essay on Protective Paints. The prize was not won simply by theoretical demonstrations, although the professor furnished scientific reasons also, but by most carefully conducted practical experiments with various pigments and oils, covering several years' time. The results demonstrated that a properly made paint of graphite and boiled linseed oil is the most suitable for protecting structural iron work, roofs, etc., exposed to the destructive agencies of heat, cold, storms, etc. Running parallel with these results are the facts demonstrated by those who have used Dixon's Silica Graphite Paint during the past 30 years. Roofs and iron work properly painted with that paint have not required painting in 15 to 20 years. Those interested should investigate for themselves the merits of this paint. The Joseph Dixon Crucible Co., of Jersey City, N. J., can furnish much information of a convincing character.

EQUIPMENT AND MANUFACTURING NOTES.

The Pennsylvania Company is in the market for 200 cars.

The Pittsburgh & Lake Erie is asking bids on 1,000 cars.

The Vandalia is reported as being in the market for 150 freight cars.

The St. Louis, Vandalia & Terre Haute is in the market for 175 cars.

The Rio Grande Western is receiving bids on 100 stock and 100 coal cars.

The Houston & Texas Central is said to be in the market for five locomotives.

The Savannah, Florida & Western is receiving bids on a lot of freight cars.

The Lake Shore & Michigan Southern is asking bids on five switching engines.

The New Orleans & Southern Railway will soon place an order for two locomotives.

The Brooks Locomotive Works have received an order for 25 engines from the Mexican Central.

The Ensign Manufacturing Company is said to have an order from the Chesapeake & Ohio for 100 cars.

The Atchison, Topeka & Santa Fe is in the market for ten 10-wheel locomotives. It will build 15 others in its own shops.

The Haskell & Barker Car Company has received the order from the Chicago, Hammond & Western for 100 stock and 40 flat cars.

The order of the Pittsburgh, Bessemer & Lake Erie for steel cars will, it is reported, be for 600.

The Schenectady Locomotive Works has received an order from the C., C., C. St. & L. Road, for two eight-wheeled passenger engines.

The Erie Railroad has contracted with the Rogers Locomotive Company for 24 Wootten boilers, to be delivered at the rate of two a month.

The Pennsylvania Railroad Company has ordered Pancoast ventilators on the new passengers cars now being constructed at the Altoona shops.

The Mexican Central Railroad has placed an order with the Michigan Peninsular Car Company at Detroit for 325 box cars, 150 coal cars and 75 stock cars.

The Kansas City, Pittsburgh & Gulf has ordered 20 caboose cars, with 28-foot bodies. It has placed an order for 400 box cars with the Missouri Car & Foundry Company, of St. Louis.

The Pennsylvania Railroad will build at its Juniata shops 10 mogul freight engines, for use on the P., C., C. & St. L. It is stated that 10 class L passenger locomotives will also be built.

The Manitou & Pike's Peak Railroad has received a new compound engine from the Baldwin Locomotive Works. The engine weighs 25 tons and its cylinders are 10 and 15 by 22 inches.

The receivers of the Baltimore & Ohio have ordered from the South Baltimore Car Works 260 coal cars, to be delivered in May. They have also ordered 2,500 freight cars from the Pullman Works.

It is reported that in addition to the 10 engines ordered of Baldwin Locomotive Works, the Kansas City, Pittsburgh & Gulf has contracted with the Manchester Locomotive Works for eight more.

The Cold Blast Transportation Company, of Kansas City, Mo., has placed an order with the Wells & French Company, Chicago, for 100 refrigerator cars, and will soon place an order for another one hundred.

The Chicago & Eastern Illinois Railroad has let a contract for 350 coal cars of 80,000 pounds' capacity to the Haskell & Barker Car Company, of Michigan City, Ind. The cars will be equipped with Tower couplers.

The Baldwin Locomotive Works recently received orders for one engine for the Spokane Falls & Northern Railroad, two for the Rio Grande, Sierra Madre & Pacific Railroad and one for the New York, Chicago & St. Louis.

The Baldwin Locomotive Works will build for the Philadelphia & Reading Coal & Iron Company a compound compressed air locomotive. This is a novelty, as it is uncommon to use compound cylinders in compressed air locomotives.

The Morgan Engineering Company, of Alliance, O., has received an order for three electric traveling cranes for Jones & Laughlin, of Pittsburgh. Two of them will have a span of 40 feet and the third 80 feet. All are of 10 tons' capacity.

The office of Secretary and Treasurer of the Sterling Railway Supply Company, is now at the company's works, Easton, Pa., to which place all future communications should be addressed. The soliciting office will remain at 256 Broadway-House, Life Building, New York.

The Rand Drill Company has received an order for a deep well air lift pumping plant for Norwood, O. The capacity is 1,000,000 gallons of water in 24 hours. It has also received an order from the Atchison, Topeka & Santa Fe for an air compressor, making eight that the Rand Drill Company has now sold to the road.

The Richmond Locomotive & Machine Works have recommenced work with a large force of workmen. Secretary G. F. Jones states that the force will be daily increased, new men being taken on as opportunity offers. The reopening of this plant will furnish work to a large number of mechanics who have been unemployed for weeks.

From Mr. J. Faessler, manufacturer of the "Boss" and improved sectional expanders as well as other tools and machines, we learn that his business is steadily increasing, the past year being the best year in the history of his shop. He says he keeps his old customers and gets new ones right along, which speaks well for the tools he furnishes them. Send for his new catalogue and keep posted.

Mr. I. P. Richards, Providence, R. I., manufacturer of punches with a double shearing cut, has recently gotten out a new and attractive illustrated circular descriptive of his goods. Mr. Richards is the original designer of that style of punch, and claims that his system of punches is the best and plainest arranged of any system in use. He states that all the builders of punching machinery have adopted it as far as possible.

The firm of Bement, Miles & Company, of Philadelphia, have recently shipped to the Bethlehem Iron Works a horizontal boring and milling machine weighing about 110 tons. They also have under construction in the shops for the same company a planing machine which will handle work 30 feet long and 8 feet high, designed for armor plate work. Both machines are of unusually large dimensions and embody special features.

The corporation heretofore doing business in New Jersey, New York and elsewhere, under and by the name of "W. A. Crook & Bro.'s Company," has recently, pursuant to the laws of the State of New Jersey, under which such corporation was and is organized, changed its corporate name from that of "W. A. Crook & Bro's Company" to that of "Lambert Hoisting Engine Company," under which latter name it will continue to do business in the same line as heretofore. Lambert Hoisting Engine Company will receive all the assets and pay all the liabilities of the W. A. Crook & Bro's Company.

The D'Este & Seeley Company report, among their recent sales, five large, flanged, composition, pressure regulators, to the Atlantic Works, Boston, for a steamer, to reduce 160 pounds boiler pressure to 80 pounds, for general use in steering, hoisting, cooking, heating, electric-light plant, etc. Also, several large regulators for use with the Paul steam system of low-pressure heating and drying. These regulators work on vacuum of 2 to 12 inches. Also, 17 large flanged regulators on an order from Copenhagen, Denmark. They have also quite recently furnished several large composition, flanged regulators for the steam yacht of the Emperor of Russia.

The Edward P. Allis Company, of Milwaukee, Wis., has purchased the business formerly carried on by the Hercules Iron Works, the Hercules Ice Machine Company and the Reliance Engineering Company, of Aurora, Ill., and is prepared to supply repairs on all ice and refrigerating plants erected by them, as well as to build new refrigerating machinery of any capacity from 1 to 500 tons' refrigeration. This well-known firm thus adds an important line of machinery to its already extensive output, and will undoubtedly display in this direction the same enterprise and ability that has characterized its work in the other lines of engine building.

The Chicago Ship Building Company will build a large machine shop at its plant on the Calumet River, Chicago.

The Colorado Fuel and Iron Company, Pueblo, Colo., contemplates remodeling its mill and putting in considerable new machinery.

The Morgan Engineering Company, Alliance, O., have sold a 25-ton electric traveling crane of 50-foot span to the Midland Steel Company, Muncie, Ind.

The Chesapeake & Ohio Railroad Company has ordered 100 hopper bottom gondola coal cars of 40 tons' capacity each, of the Ensign Manufacturing Company, of Huntington, W. Va.

The Philadelphia Engineering Company, Philadelphia, Pa., has just completed a very large steel smoke stack for an electric light plant in Yokohama, Japan. The stack is 175 feet high, 7 feet 3 inches in diameter and weighs 95,000 pounds.

Edward P. Allis Company, of Milwaukee, Wis., has received a contract for a triple-expansion pumping engine of 30,000,000 gallons capacity for the Chestnut Hill Pumping Station, at Boston, Mass. The duty guaranteed is 150,000,000 foot pounds.

Notice is given by the parties in interest that all threatened litigation against the makers and users of the Wolhaupter arch and girder tie plate for infringement of the Servis tie plate patent has been settled. The Railroad Supply Company has accepted a license under the Servis patent, and has agreed to pay a royalty.

It is reports that the Dickson Manufacturing Company, of Scranton, Pa., has contracted for the erection of a large boiler shop for its locomotive works. The shop will be equipped with modern tools for making the heaviest of boilers, including power, cranes and a complete hydraulic and pneumatic plant.

The Sargent Company, Chicago, write us that in February they had the largest month's business ever experienced in their Sargent & Ross Meehan brake shoes, several railroads adopting the Sargent Shoe as their standard, while all their old customers ordered more freely than at any previous time. In their open-hearth department they are at work on one or two large contracts, and prospects point to soon reaching the maximum capacity of the plant. They have recently started up ther crucible furnaces and are now prepared to turn out work of any size or weight.

The Michigan-Peninsular Car Company, of Detroit, recently built for the firm of Mackie, Hussey & Company, at Barre, Vermont, a flat car of 100,000 pounds' capacity, to be used for the transportation of stone. The first load it carried was a large monument base 14 feet by 14 feet by 3 feet, with a hole 8 feet square through the center of it. The stone was carried on edge, and was lowered through a pocket in the floor of the car until it cleared the rails only 8 inches. The stone weighed 61,200 pounds. The car is 36 feet long, 9 feet 2 inches wide, and weighs 41,000 pounds without the blocking for securing the stone.

Henry R. Worthington, manufacturer of steam and electric pumping machinery, have recently received a contract from the Newport News Ship Building and Dry Dock Company, for the pumps for the United States battle-ships *Kearsarge*, *Kentucky* and *Illinois*. They are also building the pumps and pumping machinery for the United States battle-ship *Alabama*, now being constructed by the Wm. Cramp & Sons Ship and Engine Building Company. From the same firm they have received a contract for the pumps for the armored cruiser being built for the Japanese government.

The Empire Portland Cement Company, of Warners, N. Y., have issued a neat folder calling attention to the fact that their cement is being used by the government for the new dam at the government water power plant at Rock Island, Ill. The dam is entirely of concrete work. Special tests of the Empire cement were made in the Government Laboratory at the Rock Island Arsenal, Ill., in September, 1896, with the result that the tensile strength (seven-day test) was shown to be 534 pounds, neat; 213⅓ pound, for a mixture of three of cement of sand to one of cement, and 180 pounds for four of sand to one of cement, giving higher results than its seven competitors in the test. In making bids for furnishing a year's supply the Empire samples were submitted by various manufacturers and the Empire showed the greatest strength and the lowest ratio of cost to strength, viz.: .00345. The Western representative of the company is C. E. Schauffler, Resident Manager, Monadnock Block, Chicago.

Our Directory

OF OFFICIAL CHANGES IN MARCH.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Alabama Great Southern.—The offices of General Superintendent, Chief Engineer, Superintendent of Motive Power, General Roadmaster and Superintendent of Bridges and Buildings have been abolished and these departments placed in control of Superintendent Wickersham.

Bloomsburg & Sullivan.—Mr. F. M. Leader has resigned as General Manager and the office is abolished. Mr. D. W. Campbell is appointed General Superintendent; office, Bloomsburg, Pa.

Buffalo, St. Mary's & Southwestern Railroad.—J. K. P. Hall has been elected Vice-President and Secretary.

Canabelle, Tallahassee & Georgia.—Master Mechanic S. A. Sheppard died March 11.

Canadian Pacific.—Mr. J. Spragge has been appointed Master Mechanic of the Atlantic Division. Headquarters, McAdam Junction, N. B.

Chicago, Rock Island & Pacific.—Mr. John Gill is appointed Master Mechanic of the Illinois Division, with headquarters in Chicago.

Columbus, Hocking Valley & Toledo.—Mr. Nicholas Monsarrat has been appointed Receiver. The office of General Manager is abolished. Mr. W. A. Mills is appointed Traffic Manager; office, Columbus, O.

Dominion Atlantic.—Mr. Wm. Grierson has resigned as Master Car Builder.

Fall Brook.—President Gen. George J. Magee died in Nice, France, on March 11.

Findlay, Fort Wayne & Western Railway.—B. W. Fenton has been appointed Chief Engineer, with office at Findlay, O.

Gainesville, Jefferson & Southern.—Mr. M. H. Dooly is Receiver.

Georgia & Alabama.—Mr. F. H. McGee has been appointed Master Mechanic, with office at Americus, Ga., vice J. E. Worswick, resigned.

Great Northern.—Mr. J. M. Barr has resigned the position of General Superintendent. Mr. Russell Harding succeeds him.

Hoxie, Pocahontas & Northern Railroad.—Maxwell Coffin is President and General Manager of this company, with office at Little Rock, Ark.

Lehigh Valley.—J. I. Kinsey is appointed Superintendent of Machinery. Mr. Philip Wallis is appointed Master Mechanic at Easton, Mr. Fred Roth at Delano, and Mr. H. D. Taylor Master Mechanic at Wilkes-Barre.

Lexington & Eastern.—Mr. J. D. Lewingston has resigned as Vice-President and General Manager. Mr. A. W. Barr is appointed General Manager and Mr. George Copeland Vice-President. Headquarters, Lexington, Ky.

Maricopa & Phœnix and Salt River Valley.—Roadmaster B. F. Porter will have charge of shops and car repairs, vice T. J. Morrison, resigned.

Minnesota & Wisconsin Railroad.—H. D. Burghardt is Purchasing Agent, with office at Spring Valley, Wis.

Missouri, Kansas & Texas.—Mr. Darius Miller has been elected Vice-President in charge of traffic.

Norfolk & Western.—Mr. James M. Barr has been elected Vice-President, with office at Roanoke, Va.

Philadelphia & Reading.—Mr. W. T. Gorrell, Assistant Master Car Builder, has been appointed Master Car Builder to succeed Mr. J. H. Rankin, promoted.

Pittsburgh, Bessemer & Lake Erie.—Mr. B. Gilbert has been appointed Master Mechanic, with office at Greenville, Pa.

Raleigh & Western Railway.—Murat Masterson has been elected Vice-President.

Seattle, Lake Shore & Eastern.—Receiver Thos. R. Brown died Feb. 2.

Southern California.—General Manager Kirtland H. Wade died suddenly March 11.

South Carolina & Georgia.—Mr. J. U. Jackson has been appointed Assistant to the General Manager. This road has leased the Augusta Southern.

Tennessee Midland.—Gen. J. C. Mann has been elected President, vice J. C. Clark, resigned.

Toledo, St. Louis & Kansas City.—C. B. McVay has been appointed Purchasing agent, with headquarters at Toledo, O.

Union Pacific.—Mr. D. Hickey has been appointed Division Master Mechanic, with office at Evanston, Wyo.

Wadley & Mt. Vernon.—Mr. G. A. Croft has been chosen Vice-President; headquarters, Atlanta, Ga.

Wheeling & Lake Erie Railway.—The office of Myron T. Herrick, Receiver, is at Cleveland, O. Robert Blickensderfer, Receiver is also General Manager, with office at Toledo, O.